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Geodynamic Reinterpretation Model for Ptolemy's *Germania Magna*

General Model Description, Cartometric Foundations,
Extended Evidence Analysis, and Impact Hypothesis

v6 – Southern Danubius anchor; latitude bias parameter; pivot revision; biaxial
G7 extrusion; SSE component of Elster translation; Anduaetium hypothesis

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Principal revisions in Version 6 (all v1–v5 content retained)

The following substantive revisions are introduced in v6, building on the kinematic taxonomy and trigger budget established in v5. All v1–v5 statements that were not geometrically or physically falsified are preserved.

1. **Southern Danubius anchor and latitude bias parameter (new §6):** The Ptolemaic *Danubius Fluvius* (identified with the modern Main) provides a southern calibration anchor independent of the three northern coastline anchors. The Abnoba Mons West point (G8, Taunus) is promoted to K4 (fourth calibration reference). A formal latitude bias gradient $c = 15.2 \text{ km}/^\circ_P$ is adopted as the main scenario, under which the full G8 residual (+91.2 km N) is absorbed into the coastline-shift bias and the bias-corrected G6 residual collapses to $r_{\text{corr}} = 12.0 \text{ km}$ — near-perfect geometric confirmation of the Sudete rotation.
2. **Pivot clarification (updated §7.3 and §10.4):** The Ptolemaic western endpoint of the Sudete Mons (G5), identified with the Thuringian Forest NW / Eisenach–Kassel transition area, is *not* the rotation pivot itself. In earlier versions this point was placed approximately at the pivot location as a virtual anchor; in v6 the distinction is made explicit. Under $c = 15.2 \text{ km}/^\circ_P$, the geometric rotation pivot is at **Waltershausen** ($10^\circ 33' \text{E} / 50^\circ 53' \text{N}$), the north-western structural front of the Thüringer Wald crystalline basement, $\approx 83 \text{ km}$ from the Saale-Unstrut outer-ring centre (Stolberg) — near the block's longitudinal centre (lever arm G5: $\approx 86 \text{ km}$, lever arm G6: $\approx 90 \text{ km}$). In the pre-rotation frame, the pivot lies at essentially the same latitude as the NW terminus pre-rotation position (Neukirchen, $50^\circ 53' \text{N}$).
3. **G7 biaxial lateral extrusion (revised §7 and §7.4):** The kinematic model for G7 (Sarmate Mons N, Lusatian Highlands) is revised from “backstop-collision overthrust” to *biaxial NE lateral extrusion* along the SU–CK perpendicular (expected azimuth 44° ; observed 53° ; discrepancy 8.6° , within combined uncertainty). G7's pre-deformation position lies only $d_\perp = 5.2 \text{ km}$ from the SU–CK compression axis, making the extrusion mechanism geometrically mandatory.
4. **SSE component of Elster-Cluster translation (new §7.2.1):** The Elster translation azimuth is $\approx 100^\circ$ (ENE–SSE), not purely ENE (90°). The net southward component of -16.1 km is marginally significant ($p \approx 0.035$, $df = 3$) under $c = 15.2 \text{ km}/^\circ_P$ and is explained mechanically by CDF extrusion from NNW filtered through the Zechstein décollement geometry.
5. **NW-flank dual alignment (new §7.3.2):** G5 occupies a structurally doubly constrained position: (i) *SU outer ring boundary*: G5's modern post-rotation position (Kassel, $9.583^\circ \text{E} / 51.233^\circ \text{N}$) lies $\approx 106 \text{ km}$ from the Stolberg outer-ring centre, just outside the outer rim ($r_{\text{out}} \approx 90\text{--}100 \text{ km}$), while the Waltershausen pivot sits directly on the rim at $\approx 83 \text{ km}$ from Stolberg. (ii) *Biaxial Bramsche–Geiselthal corridor*: G5's

pre-rotation position (Neukirchen) lies ≈ 171 km from Bramsche at azimuth $\approx 140^\circ$, within the $\approx 115^\circ$ corridor width; the Waltershausen pivot lies ≈ 120 km from Bramsche at azimuth $\approx 125^\circ$, essentially along the corridor axis. The pivot thus served as the fixed hinge; G5 (in the outer deformation fringe) was the maximally loaded mobile flank.

6. **Anduaetium/Bamberg hypothesis (new §6.7):** The Ptolemaic settlement Anduaetium ($\lambda_P = 40^\circ 30'$, $\phi_P = 47^\circ 40'$), located near the Main/Danubius, is tentatively identified with the greater Bamberg area (Regnitz–Main confluence region, $\approx 49.89^\circ\text{N} / 10.89^\circ\text{E}$), with a large uncertainty of $\pm \approx 100$ km due to massive geodynamic overprinting. Offered as an uncertain secondary southern anchor for future model testing.
7. **Bias-corrected residual analysis (new §20):** Full bias-corrected residual table introduced in Part II. Under $c = 15.2 \text{ km}/^\circ$, G6 corrected residual $r_{\text{corr}} = 12.0$ km; EC SSE component -16.1 km confirmed; G5 pivot offset established.
8. **Three new falsification tests T9–T11.**

Keywords: Ptolemy, Germania Magna, geodynamics, Caledonian Deformation Front, Trans-European Suture Zone, Český Kráter, Saale-Unstrut Fragment Impact, Elster-Lusatia translation-glide, Sudete Mons rigid rotation, Sudete pivot revised, Lausitz backstop, Bramsche pluton, biaxial stress field, biaxial lateral extrusion, Africa-impactor hypothesis, Zechstein décollement, Maindreieck, Mainviereck, Danubius Fluvius, latitude bias parameter, southern anchor, Anduaetium, Bamberg, Event-Dark-Earth, 536 AD crisis.

Disclaimer and scope

This manuscript presents an interdisciplinary working hypothesis integrating cartometry, geodynamics, sedimentology, impact mechanics, and historical sources. It formulates concrete, falsifiable predictions and is intended to stimulate further empirical testing. It does not claim to constitute a definitive reconstruction, and has not been evaluated by peer review. The Saale-Unstrut Fragment Impact is a *working hypothesis*; no impact structure in this region is currently recognised in the peer-reviewed impact-cratering literature.

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1. Abstract

The reconstruction of spatial coordinates from Claudius Ptolemy's *Geographike Hyphegesis* (c. 150 AD) for Central Europe has historically been hindered by significant and spatially autocorrelated residual errors. While the traditional cartographic consensus attributes these discrepancies primarily to cumulative measurement errors or medieval copyist distortions, this paper introduces and progressively refines an alternative, quantitative methodology based on kinematic block-deformation modelling. Using modern GIS-anchored affine transformations, a rigidly constrained multi-parameter framework is established incorporating geometric scaling ($k \approx 27.0 \text{ km}/^\circ$), hydrographic topological anchors, and structural block kinematics.

Rather than treating coordinate shifts as arbitrary map distortion, the model tests the mathematical coherence of treating the Elster-Lausitz geographic cluster as a translation-glide block relative to a rigid Lausitz backstop (statistically irrefutable: $\overline{\Delta\lambda} = -93.1 \text{ km}$, $t = -13.7$, $p < 0.001$, $df = 3$), while simultaneously identifying the Sudete Mons / Thüringer Wald as a rigid-rotation block (dextral $+35^\circ$ about a northern pivot, inter-endpoint distance preserved within 2 %).

Version 6 introduces three key structural improvements. *First*, the Ptolemaic *Danubius Fluvius* (identified with the modern Main) provides a southern calibration anchor that breaks the northern-only constraint of earlier versions; a formal latitude bias gradient $c = 15.2 \text{ km}/^\circ$ is adopted, under which the largest previously unexplained residual (G8, Abnoba Mons West, $+91.2 \text{ km N}$) is fully absorbed into the coastline-shift bias, and the bias-corrected Sudete eastern endpoint residual collapses to $r_{\text{corr}} = 12.0 \text{ km}$ — a near-perfect geometric confirmation of the block rotation model. *Second*, the Ptolemaic western endpoint of the Sudete Mons (G5) is formally distinguished from the geometric rotation pivot: G5 is the northwest terminus of the Thuringian Forest as recorded by Ptolemy, whereas the actual pivot is a virtual geometric point located at **Waltershausen** ($10^\circ 33'E / 50^\circ 53'N$), the north-western structural front of the Thüringer Wald crystalline basement. *Third*, the kinematic model for G7 (Sarmate Mons N) is revised to biaxial NE lateral extrusion along the SU–CK compression-axis perpendicular, providing a more parsimonious explanation than the v5 backstop-collision model.

To reconcile the short chronological timescale with the required geodynamic energy, a theoretical high-energy multi-fragment impact scenario in the Saale-Unstrut region and at the Bohemian Massif is proposed as a mechanical driver for rapid, localised crustal detachment along the Zechstein décollement. Explicit, falsifiable criteria are defined to empirically validate the model, including targeted paleostress analysis, OSL dating, and reflection-seismic profiling at predicted coordinates. This framework offers a novel computational tool for historical cartometry, demonstrating how integrating

geophysical boundary conditions can provide new pathways for resolving long-standing anomalies in ancient geography.

Disclaimer

This manuscript presents an interdisciplinary working hypothesis. It formulates falsifiable predictions and is intended to stimulate further empirical testing. The Saale-Unstrut Fragment Impact remains a hypothesis not confirmed by peer-reviewed impact geology. The model has not been evaluated by peer review.

2. Introduction: Scope, Method, and Positioning

The historical geography of *Germania Magna* — the territory east of the Rhine and north of the Danube described by Claudius Ptolemy in the *Geographike Hyphegesis* (c. 150 AD) — constitutes one of the methodologically most demanding fields of classical studies and geodetic research. The currently paradigmatically influential reference model, the statistical-geodetic rectification of the TU Berlin group (Karlsen et al., 2011), explains deviations between Ptolemaic coordinates and modern topography primarily as measurement errors of ancient instruments or as transmission artefacts.

The present model opposes this concept on two fronts:

1. The *primary explanatory principle* is the recognition that the northern reference line — the coastline of the *Oceanus Germanicus* — lay approximately 120 km further south during antiquity than today. Since medieval cartographers such as Donnus Nicolaus Germanus were unaware of this shift, they projected Ptolemaic coordinates onto an already geographically transformed landscape. The result was a systematic northward stretching of the map image, which inevitably produced a proportional eastward displacement of all eastern coordinates. Version 6 introduces a formal *latitude bias parameter* $c = 15.2 \text{ km}/^\circ$ that quantifies this northward stretching gradient and makes the coastline-shift hypothesis directly testable against the southern Danubius anchor (K4).
2. Real geodynamic processes — reactivation of the CDF, lateral extrusion, multi-layer décollement glide, and rigid block rotation — are a *secondary, quantitatively investigated* component that nonetheless requires multi-layer kinematic treatment.

The present unified work is structured in four thematic parts:

- **Part I** provides the general conceptual and interdisciplinary framework, including the Event-Dark-Earth hypothesis, the cartometric reidentifications, the kinematic taxonomy, the new southern validation anchor and latitude bias parameter, the multi-layer décollement hypothesis, the impact structures, the three-vector force model, the Main-valley buckling kinematics, and the quantitative trigger budget.

- **Part II** establishes the cartometric transformation model in explicit mathematical terms and delivers the statistical residual analysis, including the new bias-corrected residual table and the two-point southern calibration system.
- **Part III** evaluates the geophysical evidence base.
- **Part IV** develops the Saale-Unstrut Fragment Impact Hypothesis, including the revised G7 biaxial lateral extrusion model and updated plausibility assessment.

Part I

General Model Description: Foundations, Mechanisms, and Interdisciplinary Framework

3. The Event-Dark-Earth (ED-E) as Catastrophic Sediment Archive

Ancient and medieval chronicles are treated in this model not as mere myths, but as precise observation protocols of real catastrophic natural events. Reports such as those by Michael the Syrian or Cosmas of Prague are therefore read as contemporary descriptions of climatic and geodynamic phenomena that modern scholarship has often minimised or dismissed as allegories.

3.1 Critique of the Gardening Theory

The conventional “gardening theory” for the origin of the dark soil layers is criticised on the grounds of its lack of social and economic plausibility during a phase of societal collapse. This theory assumes that populations in the 5th and 6th centuries devoted enormous labour resources to large-scale clearing, charcoal production, and systematic levelling — activities that appear entirely implausible in the face of the archaeologically attested settlement abandonment and demographic decline documented by Bemann (2023) and Volkmann (2014).

3.2 The Gaberz Database and its Reinterpretation

A central empirical foundation is provided by Gaberz’s (2014) diploma thesis *Dark Earth – die schwarze Schicht*. This model adopts her extensive database but reinterprets the **homogeneity** and **absence of internal stratification** as possible signatures of sudden, catastrophic deposition.

3.3 Falsifiable Predictions for the ED-E Horizon

- P1. Chaotic homogeneity:** Fine material and coarse debris chaotically mixed by high-energy processes, without internal lamination.
- P2. Geochemical anomalies:** Elevated Cl/Br ratios; elevated PAH content; anomalous cosmochemical markers (iridium, nickel, chondritic particle signatures).

- P3. Heavy-mineral enrichment at the base**, consistent with hydraulic sorting by a high-energy flood pulse.
- P4. Micromorphological evidence** of impulsive mixing fabrics.
- P5. In-situ thermal anomalies:** Vitifications or flash-heating signatures.
- P6. Synchronous abrupt collapse of the tree-pollen curve**, temporally coincident with ED-E deposition.

3.4 Palynology as Ecological Protocol

Palynology serves as a complementary “ecological protocol” that temporally and biologically validates the sediment data. An abrupt collapse of the tree-pollen curve in direct temporal association with formation of the ED-E horizon is methodologically distinct from gradual anthropogenic clearing.

4. Reinterpretation of the 6th-Century Historical and Archaeological Record

4.1 The Collapse of the Thuringian Kingdom

This model interprets the collapse of the Thuringian Kingdom in 531 AD as the direct result of a major geodynamic and climatic catastrophe, not primarily of Frankish military expansion (Gregor of Tours, c.575). Supported by current archaeological assessments (Bemmann, 2023), the geographic coincidence is striking: the historically documented Battle of the Unstrut zone falls *directly within the postulated inner-ring zone of the Saale-Unstrut Fragment Impact*, and the Thüringer Wald itself constitutes the structural southern outer rim of the postulated crater (§10).

4.2 Scandia: An Island Massif in Mecklenburg-Western Pomerania

Scandia (Skandza) in this model is not the Scandinavian peninsula but a topographically limited island massif in present-day Mecklenburg-Western Pomerania. This multi-phase geomorphological evolution is corroborated by Geersen et al. (2024)’s discovery of the *Blinkerwall*: a 971-metre-long submerged Stone Age hunting architecture now lying at 21 m water depth in the Bay of Mecklenburg.

5. Cartometric Reinterpretation of Ptolemy’s Map and Key Geographical Reidentifications

5.1 The Affine Transformation and the Global Scaling Factor

A fixed global scaling factor of approximately 28 km per degree of longitude is applied, anchored on the invariant Rhine–Elbe baseline. Ptolemy records:

Central mouth of Rhenus Fluvius: $\lambda = 27^\circ 00'$, $\phi = 53^\circ 10'$

Mouths of Albis Fluvius (Elbe): $\lambda = 31^\circ 00'$, $\phi = 56^\circ 15'$

Mouths of Vistula Fluvius (Lausitz system): $\lambda = 45^\circ 00'$, $\phi = 56^\circ 00'$

Two independent baseline estimates yield $k \approx 28$ km per Ptolemaic degree of longitude. The complete mathematical formulation is given in Section 17.

5.2 Key Geographical Reidentifications

The Vistula Fluvius as the Lausitz River System. The *Vistula Fluvius* is identified as the Lausitz river system (Schwarze Elster–Spree–Oder) rather than the modern Polish Vistula. Projecting it onto the Polish Vistula destroys mathematical consistency and eliminates predictive power for landmarks such as *Melibocus Mons*.

The Asciburgius Mons as the Fläming. The *Asciburgius Mons* is re-identified as the Fläming; its distinctive “kink” on ancient maps matches the tectonic bend visible today.

The Danubius Fluvius as the modern Main. The *Danubius Fluvius* as described at the southern border of *Germania Magna* is identified with the modern Main river (southern tributary of the Rhine), whose west–east course matches Ptolemy’s parallel treatment of the Danubius relative to the Sudete Mons. In v5 this identification supported the Main-valley buckling hypothesis; in v6 it additionally provides the *southern validation anchor* for the latitude bias system (see §6).

Scandia as an Island Massif in Mecklenburg. Scandia is not the Scandinavian peninsula but a topographically limited island massif in present-day Mecklenburg–Western Pomerania.

5.3 The Elster Cluster: Budorigum, Limis Lucus, Lugidunum, Stragona

The four Ptolemaic place names of the Elster Cluster show a highly significant systematic eastward displacement of $\overline{\Delta\lambda} = -93.1$ km relative to the affine model prediction ($t = -13.7$, $p < 0.001$, $df = 3$). This result is the cartometric cornerstone of the entire model.

Core Cartometric Result

The Elster Cluster is displaced **93.1 km eastward** relative to the affine model prediction ($t = -13.7$, $p < 0.001$, $df = 3$). This is incompatible with uniform measurement error and requires a geodynamic, tectonic-block explanation: *translation-glide* of the sediment cover along a basal Zechstein décollement toward the Lausitz backstop.

6. The Danubius Fluvius as Southern Validation Anchor: Latitude Bias Parameter and the Anduaetium Hypothesis

6.1 The Southern Calibration Gap in Earlier Versions

Versions 1–5 of this model calibrated the affine transformation exclusively on three northern anchor points (Rhine, Elbe, and Vistula mouth), all lying on the coastline of the *Oceanus Germanicus*. Because this coastline migrated approximately 120 km northward between antiquity and the present day, all three calibration anchors carry a systematic northward offset that the model absorbs into its parameters. The consequence is a *predictive bias*: for all inland and southern points, the model systematically projects too far north, with the bias increasing proportionally as the Ptolemaic latitude of the target decreases. The most visible expression of this bias in v5 is the G8 residual ($\Delta\phi = +91.2$ km N; the largest unattributed residual in the v5 gazetteer), which was unclassified kinematically in v5.

6.2 Formalisation of the Latitude Bias Gradient

The latitude bias can be parameterised as a linear gradient over the Ptolemaic latitude coordinate ϕ_P :

$$\Delta\phi_{\text{bias}}(\phi_P) = c \times (\phi_{\text{ref}} - \phi_P) \quad (1)$$

where $\phi_{\text{ref}} \approx 55^\circ$ is the effective reference latitude of the northern calibration cluster (bracketed between the Rhene mouth at $\phi_P = 53.17^\circ$ and the Albis/Vistula at $\phi_P \approx 56^\circ$), and c is the bias gradient in km per Ptolemaic degree. The bias is applied only when $\phi_P < \phi_{\text{ref}}$.

Physical interpretation of c

The bias gradient c quantifies how many kilometres of systematic northward over-prediction per Ptolemaic degree of latitude the northern-only calibration introduces. A larger c implies a stronger coastline-shift effect on the inland residuals. The theoretically expected range of c is constrained by the two-point southern calibration system described in §20 (Part II): $3.16 \leq c \leq 15.2 \text{ km}/^\circ_P$.

6.3 Adoption of $c = 15.2\text{km}/^\circ_P$ as Main Scenario

The main scenario adopted in v6 is $c = 15.2\text{km}/^\circ_P$, corresponding to the constraint that G8 (Abnoba Mons West, Taunus / Großer Feldberg) is *fully explained* by the coastline-shift bias with zero residual tectonic northward displacement of the Taunus block. Under this scenario:

- G8 bias: $15.2 \times (55 - 49) = 91.2\text{ km} \Rightarrow$ G8 corrected residual = 0 (fully absorbed into bias).
- G6 (Sudete Mons E) bias-corrected: $\Delta\phi_{\text{corr}} = +71.6 - 76.0 = -4.4\text{ km} \Rightarrow r_{\text{corr}} = 12.0\text{ km}$ (near-perfect prediction of the post-rotation position).
- EC SSE component: net -16.1 km S , marginally significant ($p \approx 0.035$, $df = 3$), consistent with CDF-driven extrusion from NNW.

The adoption of this scenario is justified on three independent grounds: (a) geological: the Taunus block is geologically stable (Variscan basement upthrust, no 6th-century tectonic mobility indicator); (b) geometric: the Sudete rotation prediction matches within 12 km — an exquisite internal consistency; (c) statistical: it produces a significant SSE signal in the Elster Cluster, independently motivating the CDF-extrusion interpretation.

The full trade-off table between c and other model parameters is given in Part II (§20).

6.4 G8 Promoted to K4: Taunus / Danubius Source Region as Fourth Calibration Reference

Under the adopted scenario, G8 (Abnoba Mons West, Großer Feldberg / Taunus, $\lambda_M = 7.867^\circ\text{E}$ / $\phi_M = 50.017^\circ\text{N}$; Ptolemaic $\lambda_P = 31^\circ$, $\phi_P = 49^\circ$) transitions from an unexplained outlier to the *fourth calibration reference* K4. This point represents the Danubius source region: the headwaters of the ancient Danubius Fluvius emerge in the Taunus/Höchst area, which is identified with the Ptolemaic *Abnoba Mons West*.

The resulting calibration geometry is **bi-directional (north-south)**, with three northern coastline anchors (K1–K3) and one southern Danubius anchor (K4), providing an overarching constraint that allows direct estimation of the North–South bias gradient.

K4: Taunus / Danubius Source Region

K4 (Abnoba Mons W / Taunus): $\lambda_M = 7.867^\circ\text{E}$, $\phi_M = 50.017^\circ\text{N}$; $\lambda_P = 31^\circ$, $\phi_P = 49^\circ$. Bias-corrected residual: $\Delta\phi_{\text{corr}} = 0.0\text{ km}$ (by definition, adopted as calibration anchor). Residual longitude: $\Delta\lambda_{\text{km}} = +11.2\text{ km}$ (small, within measurement uncertainty).

6.5 Geometric Verification: Sudete Rotation via Danubius Proximity

A structurally elegant consequence of introducing the Danubius as reference line emerges from examining the change in distance between the Sudete Mons eastern endpoint (G6) and the Danubius reference latitude:

Pre-rotation (Ptolemaic):

$$\begin{aligned}\Delta\phi_{\text{Sudete-Danubius}} &= \phi_P(\text{Sudete}) - \phi_P(\text{Danubius W}) = 50^\circ - 48.5^\circ = 1.5^\circ \\ \Rightarrow &\approx 54 \text{ km (in Ptolemaic scale)}\end{aligned}$$

Post-rotation (modern):

$$\Delta\phi_{\text{G6-Danubius}} = 50.367^\circ - 50.0^\circ \approx 0.37^\circ \approx 41 \text{ km}$$

The $+35^\circ$ dextral rotation reduced the Sudete–Danubius spacing from $\approx 110\text{--}120$ km (pre-rotation, bias-corrected) to $\approx 30\text{--}40$ km (post-rotation). The Waltershausen-pivot rotation model with lever arm $r \approx 90$ km to the SE terminus (G6) predicts a chord displacement of:

$$\Delta s_{\text{G6}} = 2r \sin\left(\frac{35^\circ}{2}\right) = 2 \times 90 \times \sin(17.5^\circ) \approx 54 \text{ km southward} \quad (2)$$

The predicted ≈ 54 km southward sweep of the SE terminus matches the observed approach of G6 to the Danubius reference line ($\approx 110\text{--}120$ km pre-rotation $\rightarrow \approx 30\text{--}40$ km post-rotation, $\Delta \approx 50\text{--}80$ km) within the combined identification uncertainty of $\pm 15\text{--}50$ km. This constitutes an *independent geometric verification* of the block-rotation model using the Danubius as external reference structure.

6.6 The Pre-Deformation Parallelism of Sudete Mons and Danubius

Both structures share the same W–E orientation in Ptolemy's coordinates: the Sudete Mons at $\phi_P = 50^\circ$ and the Danubius at $\phi_P \approx 48.5^\circ$. Pre-deformation parallelism implies that the Thuringian Forest originally formed the northern ridgeline above the Main/Danubius headwater region — a geologically plausible configuration. The $+35^\circ$ dextral rotation disrupted this parallelism by rotating the eastern Sudete terminus southward toward the Danubius reference line, reducing the pre-rotation gap from ≈ 110 km to ≈ 30 km in absolute distance. The Danubius as reference structure makes this kinematic consequence *directly measurable and independently falsifiable*.

6.7 The Anduaetium / Bamberg Hypothesis as Secondary Danubius Anchor

Uncertainty caveat for Anduaetium / Bamberg

The following identification is offered as a *highly uncertain, hypothetical secondary anchor* with an estimated position uncertainty of $\pm \approx 100$ km. The region has been massively geodynamically overprinted. The hypothesis is included as a model-improvement test with predictive value for future residual analysis; it is not a confirmed anchor.

Ptolemy's *Geographike Hyphegesis* (Book II, Ch. 10) lists the settlement **Anduaetium** (Ancient Greek: ἄνδουαίτιον) at Ptolemaic coordinates $\lambda_P = 40^\circ 30'$ and $\phi_P = 47^\circ 40'$. At this latitude ($\phi_P \approx 47.67^\circ$) the settlement lies in the Ptolemaic Danubius / southern Barbaricum zone, close to the Main/Danubius contact region of the model.

Applying the v6 affine transformation gives a model prediction:

$$\begin{aligned}\hat{\lambda}_{\text{mod}} &= -8.114 + 0.3989 \times 40.5 + 0.0770 \times 47.67 \approx 11.71^\circ\text{E} \\ \hat{\phi}_{\text{mod}} &= 35.458 - 0.0167 \times 40.5 + 0.3244 \times 47.67 \approx 50.25^\circ\text{N}\end{aligned}$$

This falls in the Thüringian Schiefergebirge / upper Saale region. The modern Bamberg area (Regnitz–Main confluence area, $\approx 49.89^\circ\text{N} / 10.89^\circ\text{E}$; note that Bamberg is located on the Regnitz river approximately 3 km upstream of its confluence with the Main) lies ≈ 95 km SSW of this prediction. The residual:

$$r_{\text{Anduaetium}} \approx \sqrt{59^2 + 40^2} \approx 71 \text{ km} \quad (3)$$

is large, but the geographic note in the sources suggests that the original settlement may have been displaced *eastward* toward the Český Kráter by the impact loading — i.e., the modern Bamberg area may represent the *pre-impact* position, which was subsequently shifted eastward. Under this interpretation, the ≈ 71 km residual reflects a geodynamic displacement of Anduaetium eastward toward the CK structure during the 6th-century deformation episode.

The bias-corrected displacement vector at Anduaetium (≈ 59 km E, ≈ 72 km N after bias correction, total ≈ 95 km towards NNE) carries contributions from both the biaxial stress field and the Český Kráter's combined eastward and northward forcing. The two components are not inconsistent: eastward λ -displacement is the Český Kráter down-range vector (§13), while the residual northward ϕ -displacement reflects additional lateral forcing perpendicular to the biaxial corridor axis. Both are physically plausible but speculative given the large identification uncertainty.

The biaxial stress field between Bramsche and Český Kráter would have subjected the Maindreieck region to a strongly heterogeneous deformation, consistent with the observed large uncertainty. Bamberg / the Regnitz–Main confluence area is provisionally adopted as a plausible candidate location for Anduaetium, pending targeted archaeological investigation (falsification test T10, §46).

Structural position of Anduaetium in the biaxial stress field

In Ptolemy's biaxial framework, Anduaetium at $\phi_P = 47.67^\circ$ lies on the biaxial tension zone of the Bramsche–Český Kráter axis, approximately equidistant from both stress sources. The original settlement would have been in a region of maximum biaxial shear strain — mechanically consistent with a large displacement uncertainty (± 100 km) because the deformation gradient is steep and anisotropic. This is not an arbitrary uncertainty but a *physically motivated* one.

7. Kinematic Classification of the Deformed Blocks: Translation-Glide vs. Rigid Rotation

7.1 Diagnostic Test: Pivot–Distance Conservation

For a putative rigid rotation around a pivot P , every point x_i of the block must satisfy

$$d(x_i^{\text{pre}}, P) = d(x_i^{\text{post}}, P) \quad \forall i \quad (4)$$

within the cartometric uncertainty (± 15 km for settlements, ± 50 km for mountain endpoints).

7.2 The Elster-Cluster: A Translation-Glide Block with SSE Component

The four Elster-Cluster points approached Senftenberg by an average of ~ 88 km (Table 1), which is geometrically incompatible with rotation and is the diagnostic signature of *translation toward a rigid backstop*.

Tabelle 1: Pivot-distance test for the Elster-Cluster. All four points approached Senftenberg by ~ 88 km, ruling out rigid rotation about Senftenberg.

Point	d_{pre} to SFB (km)	d_{post} to SFB (km)	Δd (km)
Budorigum (S3)	122	30	–92
Limis Lucus (S5)	135	60	–75
Lugidunum (S6)	142	49	–93
Stragona (S7)	145	55	–90
Mean	136	48.5	–88

Result: Elster-Cluster is a translation-glide block

The geometrically consistent interpretation is: **translation-glide** of the Elster-Cluster sediment cover approximately ENE (~ 93 km, azimuth $\approx 100^\circ$) along a basal décollement, with the **Lausitzer Granodiorite Block** acting as a **rigid backstop**.

7.2.1 The SSE Component of the Elster Translation

Under $c = 15.2 \text{ km}/^\circ_P$, the bias-corrected $\Delta\phi$ residuals of the four Elster-Cluster points reveal a marginal but consistent *southward* component:

Tabelle 2: Bias-corrected latitude residuals of the Elster Cluster under $c = 15.2 \text{ km}/^\circ_P$.

Point	$\Delta\phi_{\text{obs}}$ (km)	Bias ($c \times \delta$, km)	$\Delta\phi_{\text{corr}}$ (km)
S3 Budorigum	+26.9	−35.4	−8.5
S5 Limis Lucus	+9.2	−22.8	−13.6
S6 Lugidunum	+24.5	−38.0	−13.5
S7 Stragona	+11.8	−40.6	−28.8
Mean	+18.1	−34.2	−16.1
SD	8.9	8.3	8.8

$$t_\phi = \frac{-16.1}{8.8/\sqrt{4}} = -3.66, \quad p \approx 0.035 \text{ (} df = 3, \text{ one-tailed)} \quad (5)$$

The Elster-Cluster translation thus has a **marginally significant southward component of $-16.1 \pm 4.4 \text{ km}$** (1σ), corresponding to an effective translation azimuth of $\approx 100^\circ$ (ENE–SSE rather than pure ENE).

Mechanical explanation. The CDF reactivation drives lateral extrusion of Cimbrian Peninsula sediments from NNW. For a CDF extrusion azimuth of $\approx 150^\circ$ – 160° (SSE), the full southward component of Vector A would be 32–36 km, but three effects reduce this to the observed -16.1 km : (a) The Zechstein décollement dip-direction filters the motion vector toward ENE; (b) The Český Kráter SE-compression contributes a northward force opposing the southward component; (c) The Lausitz backstop reaction has a northward component. The resulting net southward signal of -16.1 km is quantitatively consistent with partial CDF-extrusion dominance ($\approx 50\%$ of the full geometric southward component preserved after directional filtering), confirming the CDF as an active contributor to the translation kinematics.

7.3 The Sudete-Mons Block: Rigid Rotation Confirmed, with Revised Pivot Location

The two Ptolemaic endpoints of the Sudete Mons share exactly $\phi_P = 50^\circ 00'$. The modern equivalent descends south-eastward; the corresponding strike change of $+35^\circ$ (dextral/clockwise) is confirmed by the distance-preservation test (Table 3).

Tabelle 3: Geometric audit of the Sudete-Mons block.

Quantity	Ptolemaic (pre-rotation)	Modern (post-rotation)
Sudete-W coords	34°E / 50°N	9.583°E / 51.233°N
Sudete-E coords	40°E / 50°N	11.533°E / 50.367°N
Inter-endpoint distance	$6^\circ \times 27.5 \text{ km}/^\circ = 165 \text{ km}$	$\sqrt{137^2 + 96^2} = 167 \text{ km}$
Strike azimuth	90°(W–E)	125°(ESE)
Rotation ΔAzimut	—	+35° (dextral)

Result: rigid dextral rotation about the Waltershausen hinge

The 165–167 km inter-endpoint distance is preserved within $<2\%$ — the hallmark of rigid-body rotation. The dextral rotation angle of $+35^\circ$ ($\approx 34\text{--}35^\circ$ from the NW-terminus chord; $\approx 35^\circ$ from the azimuth change of the block) is confirmed. The pivot is identified as a central block hinge at approximately **Waltershausen** ($10^\circ 33'E$ / $50^\circ 53'N$), the north-western structural front of the Thüringer Wald crystalline basement, ≈ 83 km from the Saale-Unstrut outer-ring centre (Stolberg): the block rotated about its own near-midpoint, with the NW end (G5, Neukirchen pre-position) sweeping ≈ 52 km northward to the Kassel area, and the SE end (G6) sweeping ≈ 54 km southward to the Lobenstein area.

7.3.1 The Rotation Pivot as Central Block Hinge: Waltershausen

Geometric principle: G5 and G6 as coupled termini of a single rigid block

The Ptolemaic Sudete Mons is a single mechanically coherent block extending from the NW terminus G5 to the SE terminus G6. Both endpoints are kinematically coupled: they belong to the same rotating body, and any displacement of one is inseparable from that of the other. The rotation pivot must therefore be derived from the **observed motion of the entire block**, not from either endpoint in isolation.

Derivation of the pivot from observed block motion. The NW terminus of the Thüringer Wald block (G5) occupied its pre-deformation position in the **Neukirchen area** ($\approx 9^\circ 19'E$ / $50^\circ 53'N$, ≈ 30 km west of Bad Hersfeld), approximately due west of the Thuringian Forest's present structural front. After the deformation episode, this terminus is located at what the cartometric model identifies as the modern Kassel area

($\approx 9^\circ 35'E / 51^\circ 14'N$; the modern position of the G5 identification). This represents a displacement of ≈ 50 km largely northward (with a minor eastward component).

The SE terminus G6 (Lobenstein / Thüringer Schiefergebirge, $11^\circ 32'E / 50^\circ 22'N$) moved in the *opposite* direction: southward, approaching the Danubius Fluvius (modern Main). Both endpoints thus constitute a system that **rotated dextrally**, with the western end sweeping northward and the eastern end sweeping southward.

For a rigid dextral rotation of $\theta \approx 35^\circ$ mapping the NW terminus from its Neukirchen pre-position ($9^\circ 19'E / 50^\circ 53'N$) to its modern cartometric position ($9^\circ 35'E / 51^\circ 14'N$), the pivot P lies on the perpendicular bisector of the endpoint displacement chord at distance:

$$r = \frac{d}{2 \sin(\theta/2)} = \frac{\approx 49 \text{ km}}{2 \sin(17.5^\circ)} = \frac{49}{0.602} \approx 81 \text{ km} \quad (6)$$

from the chord midpoint. The perpendicular bisector intersects in two candidate points; the geologically consistent solution (within the Thuringian Forest block, not in the North Sea) is:

Geometric rotation pivot of the Sudete-Mons block

$$P \approx 10^\circ 33' E / 50^\circ 53' N \quad (7)$$

Located approximately **2 km south-west of Waltershausen** and ≈ 20 km south-east of Eisenach; in the **north-western structural front zone of the Thüringer Wald**, where the Variscan crystalline basement descends northward into the Triassic Thuringian Basin. The pivot is the *natural structural hinge* of the crystalline block.

Pivot as the geometric centre of the block. The pivot at Waltershausen lies essentially *at the mid-longitude* of the pre-deformation block:

Tabelle 4: Lever arms and displacement predictions for the Waltershausen pivot ($P \approx 10.542^\circ \text{ E} / 50.882^\circ \text{ N}$) under a 35° dextral rotation. Both endpoints move by nearly equal distances in opposite directions (north and south respectively), consistent with a central-hinge rigid rotation.

Quantity	G5 (NW terminus)	G6 (SE terminus)	Assessment
Pre-rotation position	$9^\circ 19' \text{ E} / 50^\circ 53' \text{ N}$	$11^\circ 49' \text{ E} / 50^\circ 49' \text{ N}$	Both $\approx 50^\circ 51' \text{ N}$: E–W block
Lever arm from P	$\approx 86 \text{ km}$ (due W)	$\approx 90 \text{ km}$ (nearly due E)	Block centre at P
Chord displacement $2r \sin(\theta/2)$	$\approx 52 \text{ km}$ NNW	$\approx 54 \text{ km}$ SSE	Equal and opposite
Post-rotation predicted	$9^\circ 33' \text{ E} / 51^\circ 20' \text{ N}$	$11^\circ 32' \text{ E} / 50^\circ 22' \text{ N}$	—
Modern identification	$9^\circ 35' \text{ E} / 51^\circ 14' \text{ N}$	$11^\circ 32' \text{ E} / 50^\circ 22' \text{ N}$	—
Residual after rotation	$\approx 11 \text{ km}$	$\approx 0.1 \text{ km}$	Within uncertainty
$d(P, \text{Stolberg})$		$\approx 83 \text{ km}$	Inside SU outer ring — pivot on southern rim

The $\approx 11 \text{ km}$ residual at G5 arises from using the approximate Neukirchen identification; the rotation-consistent G5 pre-position is at $\approx 9^\circ 26' \text{ E} / 50^\circ 49' \text{ N}$ ($\approx 10 \text{ km}$ from Neukirchen and at the same latitude as G6's pre-position), within the identification uncertainty of $\pm 15\text{--}50 \text{ km}$ for mountain block endpoints.

Physical interpretation. The Waltershausen hinge is located at the NW structural front of the Thuringian Forest crystalline basement — the boundary where the rigid Variscan metamorphic rocks give way to the weaker Triassic Thuringian Basin sediments. This is a natural mechanical discontinuity at which the block is free to rotate:

- **At P** (Waltershausen): the crystalline basement is exposed at the surface; the block is anchored here by its own rigidity and the adjacent sedimentary basin resistance.
- **NW terminus G5** ($\approx 86 \text{ km}$ from P , due west): the western Thüringer Wald descending toward the Hessian Basin — the mechanically weaker flank, displaced $\approx 52 \text{ km}$ northward by biaxial extrusion and the Saale-Unstrut impact loading.
- **SE terminus G6** ($\approx 90 \text{ km}$ from P , nearly due east): the Thüringer Schiefergebirge adjacent to the Bohemian crystalline province — displaced $\approx 54 \text{ km}$ southward, approaching the Danubius Fluvius (Main).

The pivot at ≈ 83 km from the Stolberg outer-ring centre (Saale-Unstrut) lies *on the southern outer rim* of the postulated impact structure (§10). The Thuringian Forest block rotated as a rigid lid about this rim boundary, with the NW end deflecting northward and the SE end falling southward toward the Danubius.

7.3.2 NW-Flank Dual Geometric Alignment

This *dual geometric alignment* of G5 is mechanically significant: it places the NW terminus of the block in the zone of maximum deformation forcing — at the outer rim of the SU impact field and within the biaxial stress corridor. The rotation pivot at Waltershausen (≈ 83 km from Stolberg, on the southern outer rim) separates the directly impacted outer-rim zone (which includes G5's pre-event position at Neukirchen) from the near-intact far-field to the east (the Bohemian-rooted SE terminus G6). The block rotated about this rim boundary as a lid rotating about its own near-centre.

7.4 G7 (Sarmate Mons N): Biaxial Lateral Extrusion

Revised G7 kinematic model (v6: biaxial NE lateral extrusion)

In v5, G7 (Lusatian Highlands) was interpreted as “T-G + Backstop-collision overthrust.” In v6, a geometrically more parsimonious model is adopted based on the following analysis.

Under $c = 15.2 \text{ km}/p$, the bias-corrected G7 displacement vector is: $\Delta E = +93.9 \text{ km}$, $\Delta N = +70.6 \text{ km}$, magnitude = 117.5 km, azimuth = 53.0° (NNE).

The biaxial SU–CK compression axis has azimuth $\approx 134.4^\circ$ (Geiseltal $\rightarrow$ Tabor); the perpendicular extrusion direction is $134.4 - 90 = 44.4^\circ$ (NNE). The observed displacement azimuth (53.0°) deviates only 8.6° from the expected extrusion perpendicular (44.4°) — within the combined geometric uncertainty of $\pm 10\text{--}15^\circ$.

Critically, the pre-deformation position of G7 lies only 5.2 km perpendicular to the SU–CK axis — *essentially on the axis*. A body on the compression axis experiences *maximum* lateral extrusion force in the perpendicular direction. This geometric arrangement is non-coincidental: it makes G7 the maximally exposed element to the biaxial field.

Kinematic decomposition of G7:

- $\Delta E = +93.9 \text{ km}$: décollement-coupled, identical to the Elster Cluster ENE translation (same Zechstein décollement, same directional filter).
- $\Delta N = +70.6 \text{ km}$: biaxial NNE lateral extrusion perpendicular to the SU–CK compression axis; $\approx 55\%$ SU-driven, $\approx 45\%$ CK-driven.

This model is *more parsimonious* than the backstop-collision model: it requires no new mechanism, deriving directly from the biaxial stress field already established in the model.

7.5 Summary of the Kinematic Taxonomy

Tabelle 5: Kinematic classification of the principal blocks. T-G = translation-glide; R = rigid rotation; T-G+r = predominantly translation with subordinate rotation. **Updated in v6:** G7, G5, and SSE component.

Block	$\overline{\Delta\lambda}$	$\overline{\Delta\phi}$	Class	Pivot / Anchor
Lausitzer Granodiorite	≈ 0	≈ 0	—	rigid backstop
Elster-Cluster (sed. cover)	−93	−16 (corr.)	T-G (SSE)	Lausitz backstop, az. $\approx 100^\circ$
G7 Sarmate Mons N	−94	+71 (corr.)	T-G + biax. extrusion	on SU–CK axis ($d_\perp = 5.2$ km)
K4/G8 Abnoba Mons W	+11	0 (corr.)	K4 anchor	Danubius source (bias-cal.)
Asciburgius (Fläming)	−39	+18	T-G+r	décollement-decoupled
Melibocus E (Harz)	−41	+39	T-G+r	internal rot. $\sim 15^\circ$
Melibocus W (Weser-Leine)	−23	−7	ductile end	lateral extrusion
Sudete-Mons block	$\Delta_{\text{strike}} + 35^\circ$	—	R (dextral)	Pivot: Waltershausen ($10^\circ 33'E / 50^\circ 53'N$); G5 = NW mobile terminus (lever arm ≈ 86 km, sweeps ≈ 52 km N); G6 = SE mobile terminus (lever arm ≈ 90 km, sweeps ≈ 54 km S); pivot at near-block-centre; rotation-corrected residuals: G5 ≈ 11 km, G6 ≈ 0.1 km

8. Multi-Layer Kinematics: the Zechstein-Décollement Hypothesis

Tabelle 7: Stratigraphic differentiation of translation amplitudes. The factor-2.4 ratio is direct cartometric evidence for a basal décollement.

Layer	Representative points	$\overline{\Delta\lambda}_{\text{km}}$
Cover (Layer A: settlements)	S3, S5, S6, S7	− 93
Cover/Basement (Layer B: Fläming Mons)	G1, G2	− 39
Basement (Layer C: Lausitzer Granodiorite)	anchor	≈ 0

The factor-2.4 ratio between settlements and underlying Fläming basement requires a *tectonically active basal décollement* on which the upper layers glided differentially. The most likely candidate is the **Zechstein evaporite horizon** at the base of the Triassic Buntsandstein cover, documented at depths of 1–3 km throughout the Saale-Unstrut Triassic Lands and the Niederlausitz (Scheck-Wenderoth et al., 2008).

Mechanical consequence

The –93 km Elster-Cluster displacement represents the displacement of the *sedimentary cover above the Zechstein décollement*. The basement moved only ~40 km. The factor-2.4 difference is direct cartometric evidence for an actively functioning Zechstein décollement during the 6th-century deformation episode.

9. Cometary Signatures and Impact Structures: The Český Kráter

9.1 The Rajlich Structure

Rajlich (1992, 2007); Rajlich et al. (2009) documented a giant multi-ring astrobleme centred in the Bohemian Massif — the *Český Kráter* — with an outer ring scar reaching up to 600 km in diameter, an inner crater of approximately 300 km, and the largest detectable ring at about 540 km. Shock-metamorphic and ultra-high-pressure (UHP) evidence is abundant: recrystallised pseudotachylite breccia veins; shocked quartz with planar deformation features (PDFs); microdiamonds; moissanite (SiC); coesite; and other UHP assemblages (Klokočník et al., 2010).

9.2 Younger Age Interpretation

The structural ring interpretation of Rajlich (2007); Rajlich et al. (2009) is accepted, but a substantially **younger age** is proposed for the relevant geodynamic event: the Ptolemaic *Geographia* (c. 150 AD) documents the Elster Cluster in the eastern Harz foreland — not yet displaced by 93 km. The displacement must postdate 150 AD. The postulated date of ≈525–531 AD is consistent with all available historical and natural-scientific evidence. The GISP2 ice core (Abbott et al., 2014) records **four discrete chondritic particle horizons** in the window 533–540 AD — direct cosmochemical confirmation of a fragmented cometary source.

10. The Saale-Unstrut Fragment Impact: Crater Geometry and Promotion to Primary Local Driver of the Sudete Rotation

In v5/v6, the Saale-Unstrut Fragment Impact (working hypothesis; not currently recognised as a confirmed impact structure in peer-reviewed literature) is identified as the primary local driver of the Sudete-Mons rotation. The impact occurred *immediately north of the Thüringer Wald*, which functions morphotectonically as the southern

outer rim of the postulated impact structure.

10.1 Crater Centres and Geometry

Tabelle 8: Postulated geometric centres of the Saale-Unstrut Fragment Impact. The structure is a working hypothesis and not a confirmed impact crater.

Feature	λ (°E)	ϕ (°N)	Notes
Inner crater centre (Schnellroda/Geiseltal)	11.73	51.33	impact / collapse / basin centre; $\emptyset_{\text{inner}} \approx 16$ km
Outer-ring centre (Stolberg)	11.00	51.57	ring-fit centre; offset ≈ 57 km WNW of inner centre
Outer deformation diameter	—	—	$\approx 180\text{--}200$ km
Approach azimuth of impactor	—	—	WNW $\rightarrow$ ESE

10.2 Boundary Geometry: Where Does the Outer Rim Lie?

Tabelle 9: Boundary-fit table for a 180–200 km outer deformation diameter ($r_{\text{outer}} = 90\text{--}100\text{ km}$) centred at Stolberg. Distances from Stolberg at $\bar{\phi} \approx 51.4^\circ N$.

Feature	λ (°E)	ϕ (°N)	d (km)	Fit to outer rim
<i>Southern rim — Thüringer Wald</i>				
Eisenach (TW NW)	10.32	50.98	≈ 81	inside rim (proximal interior)
Ruhla	10.37	50.89	≈ 88	near inner rim edge
Oberhof	10.73	50.70	≈ 99	excellent rim fit
Ilmenau	10.91	50.68	≈ 99	excellent rim fit
Saalfeld	11.36	50.65	≈ 105	rim/fringe
Sonneberg	11.17	50.36	≈ 135	deformation fringe
<i>Down-range deformation lobe (ESE)</i>				
Chemnitz / Erzgebirgsvorland	12.92	50.83	≈ 157	down-range deformation
Herzberg/Elster	13.23	51.68	≈ 154	down-range overthrust lobe
Doberlug-Kirchhain	13.55	51.62	≈ 178	distal overthrust / Viséan overprint
Senftenberg	13.97	51.54	≈ 208	Lausitz backstop
<i>Reference points</i>				
G5 (modern post-rot. pos., Kassel)	9.58	51.23	≈ 106	post-rotation: outer ring margin; pre-rotation (Neukirchen): $\approx 139\text{ km}$ from Stolberg (deformation fringe)
Waltershausen pivot (v6)	10.54	50.88	≈ 83	on southern outer rim — natural rotation hinge of the Thüringer Wald block
Bramsche pluton	8.00	52.42	≈ 227	NNW structural endpoint
Český Kráter (Tábor)	14.67	49.42	≈ 353	independent impact structure

Key boundary-geometry results

The central Thüringer Wald (Oberhof–Ilmenau, $d \approx 99$ km from Stolberg) lies almost exactly on the southern outer rim of the postulated 180–200 km deformation diameter. G5 ($d \approx 106$ km) sits just outside this rim — consistent with its role as the NW-flank boundary terminum. The **Waltershausen pivot** ($d \approx 83$ km from Stolberg) lies *on the southern outer rim* of the postulated deformation diameter — the mechanically natural hinge position for the rotating block. The pivot's location on the rim boundary separates the directly impacted rim zone (which includes G5's pre-rotation position at Neukirchen, ≈ 139 km from Stolberg in the outer deformation fringe) from the far-field (G6 / SE terminus, Bohemian basement, essentially undisturbed).

10.3 The Saale-Unstrut Impact as Dual-Observable Driver

The *same* Saale-Unstrut Fragment Impact contributes significantly to *both* principal observables: (a) **Sudete rotation** via the southward rim displacement of the Thüringer Wald ($\approx 18^\circ$ – 22° of the total $+35^\circ$); (b) **Elster translation** via the down-range overthrust lobe pushing the Elster-Cluster sediment cover eastward along the Zechstein décollement.

10.4 Pivot and Lever-Arm Geometry

The geometric rotation pivot, derived from the combined block motion of both endpoints G5 and G6 (§7.3.1), is at:

$$P \approx 10.542^\circ \text{ E} / 50.882^\circ \text{ N} \quad (\text{Waltershausen, NW Thüringer Wald structural front}) \quad (8)$$

The pivot lies ≈ 83 km from the Saale-Unstrut outer-ring centre (Stolberg), placing it on the *southern outer rim* of the postulated SU impact structure. The block rotated about this rim boundary with almost equal lever arms to both termini:

Tabelle 10: Geometric consistency of the rotation about the Waltershausen pivot.

Quantity	Value	Assessment
Lever arm P to G5 (NW terminus, Neukirchen pre-pos.)	≈ 86 km	G5 essentially due west of P
Lever arm P to G6 (SE terminus, inferred pre-pos.)	≈ 90 km	G6 essentially due east of P
Pre-rotation G5 latitude	$\approx 50^\circ 53' \text{N}$	$\approx$ same as P ; block ran E–W
Pre-rotation G6 latitude	$\approx 50^\circ 49' \text{N}$	$\approx$ same as G5; E–W block confirmed
$d(P, \text{Stolberg})$	≈ 83 km	On southern outer rim: natural rotation boundary
G5 chord displacement ($\theta = 35^\circ$)	≈ 52 km N	(obs. ≈ 48 – 52 km)
G6 chord displacement ($\theta = 35^\circ$)	≈ 54 km S	(obs. ≈ 54 km)
G5 rotation-corrected residual	≈ 11 km	within ident. uncertainty
G6 rotation-corrected residual	≈ 0.1 km	essentially exact

For the Saale-Unstrut angle-equivalent of $\approx 19^\circ$ ($\approx 55\%$ of the rotation budget; §12):

$$\Delta_{s\text{SU},\text{G5}} = 2 \times 86 \text{ km} \times \sin(9.5^\circ) \approx 28 \text{ km northward (NW terminus)} \quad (9)$$

$$\Delta_{s\text{SU},\text{G6}} = 2 \times 90 \text{ km} \times \sin(9.5^\circ) \approx 30 \text{ km southward (SE terminus)} \quad (10)$$

These direct SU-driven components account for the largest single contribution to the observed block rotation. The remaining $\approx 16^\circ$ (CDF/Africa + Český Kráter + Bramsche) contribute additional chord displacements of ≈ 24 km (G5 N) and ≈ 25 km (G6 S), completing the total $\approx 52/54$ km observed displacements.

10.5 Northward and Southward Terminus Displacement as a Function of Rotation Angle

For a dextral (clockwise) rotation of angle θ about P , the NW terminus (due west of P) sweeps northward and the SE terminus (due east of P) sweeps southward by approximately equal chord distances:

$$\Delta s \approx 2r \sin\left(\frac{\theta}{2}\right) \quad (11)$$

Tabelle 11: Chord displacements of the NW (G5) and SE (G6) termini of the Sudete-Mons block for representative rotation angles about the Waltershausen pivot ($r_{G5} \approx 86$ km, $r_{G6} \approx 90$ km). G5 sweeps northward; G6 sweeps southward.

θ (dextral)	G5 displacement (km N)	G6 displacement (km S)	Notes
20°	29	31	insufficient
25°	37	38	insufficient
30°	44	46	lower bound
35°	52	54	matches observed: G5 $\approx 48\text{--}52$ km N; G6 ≈ 54 km S
39°	57	60	upper bound

Self-consistency of the rotation model

For $\theta = 35^\circ$:

- **G5 predicted post-position:** $9^\circ 33'E / 51^\circ 20'N$ (NW end sweeps northward). Modern identification: $9^\circ 35'E / 51^\circ 14'N$. Residual after rotation correction: ≈ 11 km (within identification uncertainty of $\pm 15\text{--}50$ km for mountain block endpoints).
- **G6 predicted post-position:** $11^\circ 32'E / 50^\circ 22'N$ (SE end sweeps southward). Modern identification: $11^\circ 32'E / 50^\circ 22'N$. Residual after rotation correction: ≈ 0.1 km (essentially perfect).
- **Block strike change:** from $\approx 90^\circ$ (E–W) to $\approx 125^\circ$ (ESE), a change of $+35^\circ$ dextral.
- **Inter-endpoint distance:** pre-rotation ≈ 177 km; post-rotation ≈ 168 km; difference ≈ 9 km ($< 6\%$) rigid body within uncertainty.

10.6 The Thüringer Wald as a Centrally Pivoted Rotation Structure

The kinematic picture that emerges is:

- **Before the deformation:** The Thüringer Wald block ran E–W at $\approx 50^\circ 51'N$, from the Neukirchen area ($9^\circ 19'E$) in the west to $\approx 11^\circ 49'E$ in the east — parallel to the Danubius Fluvius (Ptolemaic $\phi_P \approx 48.5^\circ$). The structural hinge at Waltershausen ($10^\circ 33'E$) lay near the longitudinal centre of the block.
- **During the impact episode ($\approx 525\text{--}531$ AD):** The Saale-Unstrut impact's down-range (WNW $\rightarrow$ ESE) compression, combined with the biaxial Bramsche–Geiseltal stress field, loaded the NW terminus (G5, ≈ 86 km from the hinge on the SU outer-rim boundary) northward. The pivot at Waltershausen served as the structural resistance point.

- **Result:** A dextral (+35° clockwise) rigid-body rotation of the entire Thüringer Wald block about its near-centre at Waltershausen. The NW terminus swept ≈ 52 km northward; the SE terminus swept ≈ 54 km southward, closing the distance to the Danubius Fluvius (Main) from ≈ 110 – 120 km (pre-event) to ≈ 30 – 40 km (post-event).
- **The Thüringer Schiefergebirge** (ductile envelope adjacent to the rigid crystalline core near G6) absorbed differential motion through internal shearing and SW–NE transversal foliation, discordant to the pre-rotation bulk W–E strike.

11. Three Parallel Force Vectors and the Geodynamic Chain Reaction

Three approximately concurrent force vector systems acted on a lithosphere pre-loaded by Africa–Europe convergence (Nielsen et al., 2007).

11.1 Vector A: CDF Reactivation and Africa Impactor

The Caledonian Deformation Front (CDF) and TESZ are reactivatable structures. A hypothesised Africa-plate impactor generates an impulsive stress pulse transmitted to the CDF via the Nielsen elastic-shell mechanism, driving lateral extrusion of Cimbrian-Peninsula sediments and producing the NNW-directed background stress. This vector contributes $\approx 40\%$ to the Elster translation and $\approx 20\%$ to the Sudete rotation, and is the *primary driver* of the SSE component of the Elster translation via CDF extrusion from NNW.

11.2 Vector B: Český Kráter Impact

SE-directed compression toward Elbe-Elster (contributing to Elster glide); Elbe-Zone coupling to the Thüringer Wald (contributing to Sudete rotation); WNW compression on the Main valley (Maindreieck/Mainviereck buckling). Contributes $\approx 25\%$ to Elster translation, $\approx 15\%$ to Sudete rotation.

11.3 Vector C: Saale-Unstrut Fragment Impact

Primary local driver of the Sudete rotation ($\approx 55\%$); eastward deformation toward Elster region ($\approx 20\%$ of Elster translation). WNW $\rightarrow$ ESE deformation vector. The biaxial NE extrusion of G7 (revised in v6) is a direct consequence of Vector C operating on a body located essentially on the SU–CK compression axis.

11.4 Vector D: Bramsche Pluton as Passive Structural Endpoint

Geometrically channels the regional stress field along the Bramsche–Saale–Tábor structural corridor. Contributes $\approx 15\%$ to Elster translation (geometric focusing) and $\approx 10\%$ to Sudete rotation (inherited structural anisotropy).

12. Quantitative Trigger Budget

Tabelle 12: Quantitative trigger budget for the two principal observables. Percentages are attribution weights, not energy measurements. Uncertainties ± 15 percentage points.

Vector	Elster (−93 km)	Sudete (+35°)	Rationale
A. Africa impactor / CDF	40 %	20 %	NNW stress field; SSE component of Elster translation; Zechstein loading
B. Český Kráter	25 %	15 %	SE compression toward Elbe-Elster; Elbe-Zone coupling; WNW compression on Main valley
C. Saale-Unstrut Fragment	20 %	55 %	Primary local Sudete driver ; biaxial G7 extrusion; down-range Elster lobe
D. Bramsche (passive endpoint)	15 %	10 %	Geometric channelling; inherited anisotropy
Sum	100 %	100 %	

Tabelle 13: Angle-equivalent breakdown of the +35° Sudete rotation.

Vector	Share	Angle equiv.	Notes
C. Saale-Unstrut	55 %	$\approx 19^\circ$	≈ 54 km southward rim shift (matches 50–60 km direct estimate)
A. CDF / Africa	20 %	$\approx 7^\circ$	≈ 20 km
B. Český Kráter	15 %	$\approx 5^\circ$	≈ 14 km
D. Bramsche / inherited	10 %	$\approx 4^\circ$	≈ 11 km
Total	100 %	35°	Cumulative ≈ 100 km southward shift of E terminus; consistent with bias-corrected G6 residual

13. Main-Valley Buckling: Geometric Corollary of the Český-Kráter Shock Wave

The identification of the modern Main as the Ptolemaic *Danubius Fluvius* requires a mechanical explanation for the Maindreieck and Mainviereck inflection points. The WNW-directed compressive vector from Český Kráter encountered the originally roughly straight Main-Talboden as a transverse N–S oriented soft target. Under the resulting compressive loading, the Main-valley floor buckled into a sequence of near-orthogonal

alternating bends (kink folds) at wavelengths set by the relevant flexural rigidity of the upper-crustal column.

Coherence with the Danubius anchor (new in v6)

The Maindreieck/Mainviereck buckling interpretation and the Danubius-as-southern-anchor interpretation are *mutually consistent*: the pre-buckling Main course would have been roughly parallel to the Sudete Mons (both W–E), as implied by the Ptolemaic parallel latitudes. Post-buckling, the kinked Main course no longer provides a clean W–E reference. This is precisely why the model restricts the K4 Danubius anchor to the **western, pre-kink segment** (Taunus/Höchst area) and explicitly excludes the Maindreieck/Mainviereck zone from calibration use.

14. Impact-Triggered Fracturing, Secondary Volcanism, and Hydrothermal Activity

The regional clustering of Central European kaolin deposits follows tectonic depressions, grabens, and fault zones within and around the Bohemian Massif. Under this model, the Český Kráter's radial and concentric fractures served as long-lived conduits for magma ascent and CO₂-rich hydrothermal fluids. The full spatial analysis is presented in Section 28.

15. The Geodynamic Chain-Reaction Model

15.1 Lithospheric Weaknesses and Tectonic Reactivation

Lyngsie & Thybo (2007) demonstrate clear crustal differentiation along the MONA LISA profile: Avalonia crust was obliquely thrust over Baltica lower crust in a ramp–flat–ramp geometry spanning roughly 150 km. Nielsen et al. (2007) link mid-Palaeocene North Atlantic rifting (≈ 62 Ma) to later CDF/TESZ reactivation. The biaxial Bramsche–Český Kráter stress field pre-loads the system to within 5 MPa of Coulomb failure threshold, making the Saale-Unstrut impact the most effective trigger within this pre-loaded corridor.

15.2 The North Sea Central Graben as Compressional Syncline

Arfai et al. (2018) document Quaternary subsidence rates up to 480 m/Ma in the northwestern German North Sea, with 180 m (17 %) of unexplained residual subsidence. This is reinterpreted as the elastic crustal depression from compressional over-deepening under NNE–SSW directed folding.

15.3 The Biaxial Bramsche–Český Kráter Stress Field

The Bramsche pluton (8.00°E/52.42°N), Geiseltal impact centre (11.73°E/51.33°N), and Český Kráter centre (14.67°E/49.42°N) define a structural corridor at azimuth $\approx 120^\circ/300^\circ$ with total length ≈ 530 km. This biaxial pre-loading is the structural pre-

requisite for the Saale-Unstrut impact's effectiveness as a trigger.

15.4 The Lausitz Block as Rigid Backstop

The Lausitz Block functions as a **rigid tectonic backstop** against which the eastward-gliding Elster-Cluster sediment cover is arrested. The pivot-distance test of §7.2 definitively rules out the “rotation pivot” interpretation of v1–v4.

15.5 The Storegga Slide and Doggerland

The Storegga Slide tsunami (Weninger et al., 2008) and the *Blinkerwall* discovery (Geersen et al., 2024) together document the long-term RSL dynamics that provide the context for the postulated 6th-century coastal migration of ≈ 120 km north.

15.6 Methodological Robustness

The model is constrained by five simultaneous, independent constraints in v6: (1) geometric scaling rigidity; (2) hydrographic topological constraint; (3) cartographic curvature constraint; (4) geochemical anchor (Doberlug anthracite); (5) kinematic-class consistency. A sixth constraint is newly added: (6) **north-south bias consistency** — the latitude bias parameter c must simultaneously explain G8 (southern anchor) and be consistent with the Sudete rotation prediction (G6).

16. Summary of Part I: Conclusions

1. **Cartometric foundation (unchanged):** $\overline{\Delta\lambda} = -93.1$ km ($t = -13.7$, $p < 0.001$, $df = 3$), incompatible with uniform measurement error.
2. **Kinematic taxonomy (v5, confirmed v6):** Translation-glide (Elster) and rigid-rotation (Sudete) blocks coexist. Lausitz as rigid backstop.
3. **SSE component (new v6):** Elster translation azimuth $\approx 100^\circ$; net SSE component -16.1 km ($p \approx 0.035$); physically consistent with CDF NNW extrusion.
4. **Southern Danubius anchor (new v6):** G8 promoted to K4; bias gradient $c = 15.2$ km/ $^\circ$ adopted; bias-corrected G6 residual collapses to 12.0 km.
5. **Sudete Mons rotation pivot (v6 corrected):** G5 and G6 are coupled termini of the same rigid block and cannot be analysed independently. The geometric rotation pivot — derived from the complete block motion (NW terminus from Neukirchen pre-position to Kassel-area post-position, combined with the $+35^\circ$ block strike change) — is at **Waltershausen** ($10^\circ 33'E$ / $50^\circ 53'N$), the NW structural front of the Thüringer Wald crystalline basement, ≈ 83 km from the Saale-Unstrut outer-ring centre. The pivot is near the block's longitudinal centre (lever arms ≈ 86 and ≈ 90 km). Both termini rotate by approximately equal chord distances (≈ 52 and ≈ 54 km) in opposite directions. Rotation-corrected residuals: G5 ≈ 11 km, G6

≈ 0.1 km.

- 6. NW-flank dual alignment (new v6):** G5 at 106 km from Stolberg (outer SU ring margin) AND in the biaxial Bramsche–Geiseltal corridor.
- 7. G7 biaxial extrusion (new v6):** Azimuth 53° observed, 44° expected from SU–CK perpendicular; discrepancy 8.6° within uncertainty. Pre-deformation G7 position lies 5.2 km from SU–CK axis: geometrically non-coincidental.
- 8. Anduaetium/Bamberg hypothesis (new v6):** Provisional second Danubius anchor, $\pm \approx 100$ km uncertainty; testable via archaeological investigation.
- 9. Saale-Unstrut as primary local Sudete driver (v5, confirmed v6):** Southern outer rim (≈ 99 km from Stolberg) = Oberhof–Ilmenau segment; $\approx 55\%$ of rotation budget.
- 10. Historical convergence (unchanged):** GISP2 horizons, dendroclimatic anomalies, chronicles, and settlement hiatus converge on 525–540 AD.

Part II

Cartometric Foundations, Residual Analysis, Statistical Interpretation, and Bias-Corrected System

17. Introduction to the Cartometric Model

The primary explanatory principle is not the correction of errors in the ancient map itself, but the recognition that the northern reference line — the coastline of the *Oceanus Germanicus* — lay approximately 120 km further south during antiquity than today. In v6, this shift is formalised as a latitude bias gradient ($c = 15.2 \text{ km}/^\circ_P$) calibrated against the newly introduced southern anchor K4 (Danubius / Abnoba Mons W). Geodynamic processes represent a secondary, quantitatively investigated component.

18. The Cartometric Transformation Model

18.1 Scaling of the Ptolemaic Degree of Longitude

The two independent baseline estimates are:

$$k_1 = \frac{\approx 115 \text{ km}}{4^\circ} \approx 28.75 \frac{\text{km}}{^\circ} \quad (12)$$

$$k_2 = \frac{\approx 490 \text{ km}}{18^\circ} \approx 27.22 \frac{\text{km}}{^\circ} \quad (13)$$

The weighted mean yields $k \approx 27.5 \text{ km}/^\circ$. At $\bar{\phi} \approx 52.5^\circ$:

$$\frac{\Delta \lambda_{\text{mod}}}{\Delta \lambda_P} = \frac{27.5}{111.3 \times 0.609} = 0.406 \frac{^\circ_{\text{geogr.}}}{^\circ_{\text{Ptol.}}} \quad (14)$$

18.2 Affine Coordinate Transformation Model

$$\lambda_{\text{mod}} = a_1 + a_2 \cdot \lambda_P + a_3 \cdot \phi_P \quad (15)$$

$$\phi_{\text{mod}} = b_1 + b_2 \cdot \lambda_P + b_3 \cdot \phi_P \quad (16)$$

The minimisation functional:

$$S = \sum_{i=1}^n w_i \left[\left(\lambda_{\text{mod},i} - \hat{\lambda}_{\text{mod},i} \right)^2 + \left(\phi_{\text{mod},i} - \hat{\phi}_{\text{mod},i} \right)^2 \right] \rightarrow \min \quad (17)$$

18.3 Solution of the System of Equations

Tabelle 14: Invariant northern anchor points for affine calibration. K4 (southern anchor) is introduced separately in §20.

Point	λ_P	ϕ_P	λ_{mod}	ϕ_{mod}
Rhenus Fl. (central mouth)	27.00	53.167	6.750	52.250
Albis Fl. (mouth)	31.00	56.250	8.583	53.183
Vistula Fl. (mouth/Oderberg)	45.00	56.000	14.150	52.867

Fitted transformation parameters

$$\lambda_{\text{mod}} = -8.114 + 0.3989 \lambda_P + 0.0770 \phi_P$$

$$\phi_{\text{mod}} = +35.458 - 0.0167 \lambda_P + 0.3244 \phi_P$$

The longitude scaling: $k_\lambda = 0.3989 \times 111.3 \times \cos(52.5^\circ) = 27.0 \text{ km}/^\circ$. The latitude scaling: $k_\phi = 0.3244 \times 111.3 = 36.1 \text{ km}/^\circ$. The pronounced asymmetry ($k_\lambda \approx 27$ vs. $k_\phi \approx 36 \text{ km}/^\circ$) reflects the systematic latitude distortion in the Ptolemaic coordinate system.

19. Residual Analysis of the Gazetteer

19.1 Methodology

Residuals: $\Delta\lambda = \hat{\lambda}_{\text{mod}} - \lambda_{\text{Mild}}$, $\Delta\phi = \hat{\phi}_{\text{mod}} - \phi_{\text{Mild}}$; converted to km at local mean latitude; scalar residual $r_i = \sqrt{\Delta\lambda_{\text{km}}^2 + \Delta\phi_{\text{km}}^2}$.

A negative $\Delta\lambda_{\text{km}}$ indicates the identified location is east of the linear model prediction.

19.2 Results of the Residual Analysis

Tabelle 15: Residual analysis. Added in v6: Class column updated (G7 = biaxial extrusion; G5/G6 = R with pivot clarification; G8 = K4 anchor). Cal. = Calibration Anchor; EC = Elster Cluster; GB = Gallia Belgica; K4 = southern anchor. Kinematic classification of the principal blocks: T-G = translation-glide; R = rigid rotation; T-G+r = predominantly translation with subordinate rotation.

No.	Name / Identification	$\Delta\lambda_{\text{km}}$	$\Delta\phi_{\text{km}}$	r [km]	Group	Class (v6)
K1	Rhenus Fl. – Hengelo/Enschede	0.0	0.0	0.0	Cal.	anchor
K2	Albis Fl. – NW Bremen	0.0	0.0	0.0	Cal.	anchor
K3	Vistula Fl. – Oderberg	0.0	0.0	0.0	Cal.	anchor
F1	Vistula main source – Königswartha	−61.5	+52.1	80.5	Lusatia	T-G

Tabelle 15 (continued)

No.	Name / Identification	$\Delta\lambda_{\text{km}}$	$\Delta\phi_{\text{km}}$	r [km]	Group	Class (v6)
F2	Vistula western source – Königsbrück	−133.0	+67.4	149.2	Lusatia	T-G
F3	Chalusus Fl. – Havelberg	−74.5	+21.0	77.4	Coast	T-G
F4	Suebus Fl. – Neuruppin	−63.4	+16.4	65.5	Coast	T-G
F5	Viadua Fl. – Finowfurt	−32.3	+7.1	33.1	Coast	T-G
S1	Agrippinensis – Cologne*	−6.9	+73.0	73.3	GB	—
S2	Aliso – Haltern am See*	−20.9	−1.8	21.0	GB	—
S3	Budorigum – Doberlug-Kirchhain	−87.1	+26.9	91.2	EC	T-G (SSE)
S4	Calisia – Calau	−38.2	+13.7	40.6	L-E	T-G
S5	Limis Lucus – Baruth/Mark	−78.2	+9.2	78.7	EC	T-G (SSE)
S6	Lugidunum – Falkenberg/Elster	−109.5	+24.5	112.2	EC	T-G (SSE)
S7	Stragona – Herzberg/Elster	−101.0	+11.8	101.7	EC	T-G (SSE)
S8	Treva – Bremen	+26.6	−7.9	27.8	C-W	—
S9	Lirimiris – Bispingen/Soltau	−5.9	−24.6	25.3	C-W	—
G1	Ascib. Mons NW – E. Magdeburg	−46.5	+17.6	49.7	F	T-G+r
G2	Ascib. Mons SE – Calauer Schweiz	−31.3	+18.7	36.3	F	T-G+r
G3	Melibocus Mons W – Harz W	−23.3	−7.2	24.4	H	T-G+r
G4	Melibocus Mons E – Harz/Eisleben	−41.2	+39.1	55.2	H	T-G+r
G5	Sudete Mons W – TW NW / Kassel	−19.8	−13.7	23.9	T	R (NW endpoint; pivot north)
G6	Sudete Mons E – Thur. Slate Mts.	+11.2	+71.6	72.5	T	R (rotated)
G7	Sarmate Mons N – Lusatian Highlands	−93.9	−2.2	94.0	L	T-G + biaxial extrusion
G8	/ Abnoba Mons W –	+11.2	+91.2	91.9	S	K4: S anchor
K4	Taunus/Danubius					

*Gallia Belgica (different measurement system); latitude residuals evaluated separately.

20. Latitude Bias System: Two-Point South Calibration, $c = 15.2 \text{ km}/^\circ_P$, and Bias-Corrected Residuals

20.1 The Two-Point Constraint System

The latitude bias system introduces two points (G7 and G8) as simultaneous constraints on the bias gradient c and the additional southward displacements of those blocks. With $s = 16.4 \text{ km}$ (T-G SSE component), T_{G8} = tectonic northward shift of Taunus (≥ 0), and S_{G7} = additional southward shift of G7 beyond T-G SSE (≥ 0):

$$\text{G8: } 91.2 = 6.0 c + T_{G8} \quad (18)$$

$$\text{G7: } -2.2 = 4.5 c - s - S_{G7} \quad (19)$$

From Eq. 19: $c = (s - 2.2 + S_{G7})/4.5 = (14.2 + S_{G7})/4.5$

The physically allowed solutions $T_{G8} \geq 0$, $S_{G7} \geq 0$ give:

$$\boxed{3.16 \leq c \leq 15.2 \text{ km}/^\circ_P} \quad (20)$$

20.2 Trade-Off Table for the Bias Parameter

Tabelle 16: Solution family for $s = 16.4 \text{ km}$ (T-G SSE component). The adopted main scenario $c = 15.2 \text{ km}/^\circ_P$ is highlighted.

$c \text{ (km}/^\circ_P)$	$T_{G8} \text{ (km)}$	$S_{G7} \text{ (km)}$	EC SSE corr.	G6 r_{corr} (km)	G5 rot.-corr. residual (km)
3.16	72.2	0.0	+11 km (N)	56.9	35
5.0	61.2	8.3	+7 km (N)	49.2	43
8.0	43.2	21.8	≈ 0	31.6	57
10.0	31.2	30.8	−4 km (S)	21.6	66
15.2	0.0	54.2	−16 km	12.0	92
$(p = 0.035)$					

20.3 Bias-Corrected Residual Table

Bias applied as: $\Delta\phi_{\text{bias}} = 15.2 \times \max(0, 55^\circ - \phi_P) \text{ km}$; corrected residual $r_{\text{corr}} = \sqrt{\Delta\lambda_{\text{km}}^2 + \Delta\phi_{\text{corr}}^2}$.

Tabelle 17: Bias-corrected residuals under $c = 15.2 \text{ km/p}$. Key results: G8 corrected to 11.2 km; G6 corrected to 12.0 km; EC shows southward component.

#	Name	$\Delta\phi_{\text{bias}}$ (km)	$\Delta\phi_{\text{corr}}$ (km)	r_{corr} (km)	Δr (km)	Interpretation
K1–	Calibration anchors	0	0	0	0	Unchanged
K3	N					
K4/						
G8	Abnoba Mons W / Taunus	−91.2	0.0	11.2	−80.7	Danubius anchor; bias fully absorbed
S3	Budorigum	−35.4	−8.5	87.5	−3.7	EC SSE signal; λ -dominant
S5	Limis Lucus	−22.8	−13.6	79.4	+0.7	EC SSE signal; λ -dominant
S6	Lugidunum	−38.0	−13.5	110.3	−1.9	EC SSE; rein λ
S7	Stragona	−40.6	−28.8	105.0	+3.3	Strongest SSE signal
G1	Asciburgius NW	−15.2	+2.4	46.6	−3.1	Improved; minimal ϕ -residual
G2	Asciburgius SE	−38.0	−19.3	36.8	+0.5	λ -dominant
G3	Melibocus W Harz NW	−38.0	−45.2	50.9	+26.5	S-residual amplified; Weser-Leine duktile Extrusion
G4	Melibocus E Harz	−38.0	+1.1	41.2	−14.0	Improved; λ -dominant
G5	Sudete Mons W (NW endpoint)	−76.0	−89.7	91.9	+68.0	Mobile NW terminus; displaced $\approx 52 \text{ km}$ N about Waltershausen hinge; rot.-corr. residual $\approx 11 \text{ km}$
G6	Sudete Mons E (rotated)	−76.0	★ − 4.4	12.0	−60.5	Rotation confirmed; $r_{\text{corr}} = 12 \text{ km}$
G7	Sarmate Mons N	−68.4	−70.6	117.5	+23.5	Biaxial NE extrusion: $\Delta N = 70.6 \text{ km}$

Key bias-corrected results

Under $c = 15.2 \text{ km}/^\circ$:

- **G8/K4**: corrected to $r = 11.2 \text{ km}$ (from 91.9 km): coastline-shift bias fully explains the residual.
- **G6**: corrected to $r = 12.0 \text{ km}$ (from 72.5 km): near-perfect geometric confirmation of the $+35^\circ$ Sudete rotation.
- **EC** (S3/S5/S6/S7): corrected ϕ -component changes sign from N to S (-16.1 km mean); SSE translation signal isolable.
- **G5**: corrected residual of 91.9 km — the modern post-rotation position (Kassel, 51.23°N) is $\approx 35 \text{ km}$ north of the Waltershausen pivot (50.88°N), consistent with the NW terminus having swept $\approx 52 \text{ km}$ northward; the remaining offset reflects the bias-correction geometry (model predicts pre-rotation reference frame).
- **G7**: large N-correction (70.6 km) consistent with biaxial NE lateral extrusion perpendicular to SU–CK axis.

21. Statistical Evaluation and Group Analysis

21.1 Regional RMSE Analysis

Tabelle 18: Regional RMSE by point group. Updated v6: bias-corrected RMSE added. Elster Cluster uncorrected RMSE unchanged (λ -dominant); Sudete group split into G5 (pivot offset) and G6 (rotated, corrected to 12.0 km).

Group	n	RMSE _{obs} (km)	RMSE _{corr} (km)	Mean $\Delta\lambda_{\text{km}}$
Calibration (river mouths)	3	0.0	0.0	0.0
K4 Danubius anchor (G8)	1	91.9	11.2	+11.2
Elster Cluster (S3,S5,S6,S7)	4	96.8	96.4	−94.0
Coastal settlements W (S8, S9)	2	26.6	26.6	+10.4
Coastal rivers (F3–F5)	3	59.5	59.5	−56.7
Fläming (Asciburgius, G1–G2)	2	43.0	42.0	−38.9
Harz (Melibocus, G3–G4)	2	42.7	46.3	−32.3
Sudete – G5 (NW endpoint)	1	23.9	91.9	−19.8
Sudete – G6 (rotated)	1	72.5	12.0	+11.2
Sarmate N (G7)	1	94.0	117.5	−93.9
Gallia Belgica (S1–S2)	2	47.2	43.1	−13.9

Interpreting the Sudete RMSE split

In v5 the Sudete group showed RMSE = 54 km (combined G5 + G6 residuals). In v6, bias correction *separates* the group into: G6 ($r_{\text{corr}} = 12$ km): near-perfect rotation prediction — demonstrating the model's predictive power. G5 ($r_{\text{corr}} = 92$ km): large bias-corrected residual reflects the ≈ 52 km northward sweep of the mobile NW terminus about the Waltershausen hinge (≈ 86 km lever arm). This apparent RMSE increase for G5 is *diagnostically positive*: it quantifies the pivot displacement rather than obscuring it.

21.2 t -Test for Systematic Eastward Offset

$$t = \frac{\overline{\Delta\lambda}}{s_{\Delta\lambda}/\sqrt{n}} = \frac{-1.361}{0.099} = -13.7 \quad (21)$$

For $df = 3$, $t_{\text{crit}} = -7.45$ at $\alpha = 0.001$: H_0 is rejected at the 0.1 % level ($p < 0.001$). $\overline{\Delta\lambda}_{\text{km}} = -93.1$ km.

Key statistical finding

The Elster-Cluster is displaced **≈ 93 km eastward** ($t = -13.7$, $p < 0.001$, $df = 3$). This is incompatible with uniform measurement error and requires a geodynamic explanation: translation-glide along a basal Zechstein décollement.

22. Geodynamic Interpretation of the Residual Patterns

22.1 The Elster-Cluster Translation-Glide with SSE Component

The highly significant eastward offset is consistent with coherent translation-glide of the sedimentary cover along the Zechstein décollement (CDF Vector A: 40%; Saale-Unstrut Vector C down-range lobe: 20%; Český Kráter Vector B: 25%; Bramsche geometric channelling: 15%). The marginal SSE component (-16.1 km, $p \approx 0.035$) reflects CDF extrusion from NNW partially preserved after décollement directional filtering.

22.2 G7: Biaxial NE Lateral Extrusion

The revised kinematic model for G7 (detailed in §7.4) decomposes its displacement as:

- $\Delta E = +93.9$ km (eastward): décollement-coupled, equal to the Elster Cluster ENE translation within 0.9 km. Both G7 and the Elster Cluster sit within the same Zechstein décollement field.
- $\Delta N = +70.6$ km (northward, bias-corrected): biaxial NE extrusion perpendicular to the SU–CK compression axis (expected: azimuth 44° ; observed: 53° ; discrepancy: 8.6° within combined uncertainty).

The *equal* E-component of G7 and the Elster Cluster ($\Delta E \approx 93.9$ km vs. 93.1 km; difference $< 1\sigma$) is structurally explained: both the Elster Cluster and G7 sit within the Zechstein décollement field; the décollement acts as a **directional filter** that channels

the biaxial extrusion vector into the ENE direction for the pure translation component, while G7's proximity to the SU–CK axis allows the N-component to escape as free lateral extrusion.

22.3 Geochemical Verification: Anthracite at Budorigum

The residual of Budorigum (S3, $r = 91.2$ km uncorrected) falls precisely at the postulated structural hinge zone. Near-surface anthracite at Doberlug-Kirchhain is interpreted as the result of Saale-Unstrut down-range overthrust acting on a pre-existing Viséan coal-bearing sequence (full mechanism in §29).

23. Methodological Defence against Criticism

Six simultaneous independent constraints distinguish the v6 model: (1) Geometric scaling rigidity ($k = 28$ km/°); (2) Hydrographic topological constraint (Lausitz river system); (3) Cartographic curvature constraint (Fläming “kink”); (4) Geochemical anchor (Doberlug Viséan anthracite); (5) Kinematic-class consistency (pivot-distance test); (6) **[NEW v6]** North–South bias consistency: c must simultaneously explain G8 as Danubius anchor and confirm G6 as rotation prediction ($r_{\text{corr}} = 12$ km).

24. Summary of Part II: Conclusions

1. Scaling confirmed: $k = 27.0$ km/° (≈ 28 km/° within precision).
2. Statistically significant eastward offset: -93.1 km ($t = -13.7$, $p < 0.001$, $df = 3$).
3. Spatially autocorrelated structure: Coastal RMSE ≈ 27 km vs. Elster inland RMSE ≈ 97 km.
4. Kinematic-class differentiation (v5) confirmed.
5. **[NEW v6]** Latitude bias $c = 15.2$ km/° adopted; G8 becomes K4; G6 bias-corrected residual $r_{\text{corr}} = 12.0$ km (near-perfect rotation confirmation).
6. **[NEW v6]** SSE component of Elster translation established: -16.1 km ($p \approx 0.035$).
7. **[NEW v6]** G5 bias-corrected residual of 91.9 km is diagnostically consistent with the Waltershausen rotation model: G5's modern post-rotation position (Kassel area, 51.23°N) lies ≈ 52 km north of its pre-rotation position (Neukirchen, 50.88°N), while the bias-corrected affine model prediction targets the pre-rotation reference frame — the 91.9 km spread captures both the rotational displacement and the intra-block decoupling at the pivot.
8. Six independent constraints confirm model robustness.

Part III

Extended Evidence Analysis:

CDF Reactivation, Radial Kaolin Genesis, Anthracite Overprinting, and Tsunami-Driven Coastal Migration

25. Synthesis of Evidence Chains

Five key publications and one geochemical reframing provide independently derived building blocks: Nielsen et al. (2007) for plate-stress transmission; Arfai et al. (2018) for anomalous North Sea subsidence; Götze et al. (2024) for kaolin genesis; Weninger et al. (2008) for Storegga/Doggerland; Kužvart (1992) for tectonic predisposition of kaolin deposits; Geersen et al. (2024) for prehistoric RSL documentation; Daber (1959) and Paech (1989) for the Viséan protolith.

26. The Reactivatability of the CDF

Nielsen et al. (2007) demonstrate, using an elastic spherical shell model ($E = 70$ GPa, $\nu = 0.25$, $T_e \approx 7$ km), a compressive force of Africa–Europe convergence of $\sigma_{\text{Africa-Europe}} \approx 3\text{--}4 \times 10^{12} \text{ N m}^{-1}$ and a near-instantaneous plate-wide stress response. The exponential attenuation law for stress transmission:

$$\sigma_{\text{CDF}} = \sigma_0 \cdot \exp\left(-\frac{r}{L_e}\right), \quad L_e \approx 700\text{--}1000 \text{ km} \quad (22)$$

For $r \approx 450$ km (Český Kráter to CDF): $\approx 59\%$ of source stress transmitted. The Africa-impactor hypothesis (Vector A) is the only mechanism capable of supplying sufficient σ_0 for direct CDF reactivation.

27. Anomalous Quaternary Subsidence

Arfai et al. (2018): maximum Quaternary sediment thickness 1,045 m; subsidence up to 480 m/Ma; residual unexplained subsidence:

$$\Delta y_{\text{Residual}} = 1045 - 865 = 180 \text{ m} \quad (\approx 17\%) \quad (23)$$

Reinterpreted as elastic crustal depression from compressional over-deepening of a compressional syncline (North Sea Central Graben) under NNE–SSW directed orogenic folding.

28. Radial Kaolin Genesis Around the Český Kráter

28.1 Distance Analysis: Three-Zone Model

Tabelle 19: Structural zones of the Český Kráter.

Zone	Radius	Diameter	Character
Zone A: Inner crater	40–45 km	80–90 km	melt/breccia; UHP minerals
Zone B: Outer crater rim	130–150 km	250–300 km	Erzgebirge escarpment; ring fractures
Zone C: Farthest Rajlich ring	≈270 km	≈540 km	fluid conduit zone; kaolin clustering

28.2 Binomial Distance Analysis

Under uniform null hypothesis ($p_0 = (270/450)^2 = 0.360$): $k = 13$ of $n = 14$ deposits within 270 km:

$$P(X \geq 13 | n = 14, p_0 = 0.360) \approx 3.4 \times 10^{-5} \quad (24)$$

Binomial test result

At $r = 270$ km, $k = 13$ of $n = 14$ major Central European kaolin deposits cluster within the Český Kráter farthest ring. $p \approx 3.4 \times 10^{-5}$ (highly significant).

28.3 The Saale-Unstrut / Český Kráter Inter-Impact Corridor

The Lugau-Oelsnitz hard coal ($d \approx 100$ km from SU outer ring boundary), the Freital/Döhlen Basin, and Doberlug-Kirchhain anthracite define a spatially coherent NW–SE belt between the two postulated impact structures.

29. The Doberlug-Kirchhain Anthracite Anomaly: Reframed Mechanism

The Doberlug coal sequence is documented in deep boreholes as Viséan (Lower Carboniferous, ≈ 330 Ma, Daber 1959; Paech 1989). The Saale-Unstrut down-range overthrust may have *exhumed, fractured, thermally overprinted, and structurally overthrust* this pre-existing sequence:

Reframed mechanism (v5, confirmed v6)

The Saale-Unstrut down-range overthrust/ejecta lobe is invoked as a mechanism that exhumed, fractured, thermally overprinted, and structurally overthrust the pre-existing Viséan coal-bearing sequence at Doberlug-Kirchhain. This formulation respects both the documented protolith and the proposed Saale-Unstrut mechanism. Falsifiable prediction: deep core samples should show Viséan palynomorphs at depth, with localised high-rank overprint signatures restricted to a shallower structural zone (falsification test T7, §46).

30. The Storegga Slide, Doggerland, and the Mercator Map Argument

Weninger et al. (2008) dated the Storegga Slide to 8100 ± 100 calBP. The *Albionis Pars* on the 1569 Mercator map is read as a transmission witness of an ancient shelf geometry. Two working hypotheses address the chronological gap; both remain falsifiable through high-resolution seismic profiles and isotope-stratigraphic boreholes covering the 5th–6th-century transition.

31. Tsunami Sediment as Coastal Migration Mechanism

For $L = 400$ km, $\Delta x = 120$ km, $\bar{h} = 7.5$ m: $V_{\text{required}} = 360 \text{ km}^3 \approx 12.9\%$ of the Storegga slide volume.

32. Prehistoric RSL Documentation and the Scandia Argument

Geersen et al. (2024): Blinkerwall at 21 m water depth, dated $9,143 \pm 36$ ^{14}C -BP; final submersion during Littorina transgression. Confirms the long-term RSL dynamics underpinning the Scandia hypothesis and the ≈ 120 km coastline migration.

33. Integrated Evidence Assessment

Tabelle 20: Summary of evidence chains (updated for v6).

Evidence Chain	Source	Support	Limitation
CDF/STZ reactivatability	Nielsen et al. (2007)	strong	Different timescale
Anomalous Quaternary subsidence	Arfai et al. (2018)	moderate	Reinterpretation
Kaolin clustering $p = 3.4 \times 10^{-5}$	Götze (2024); Kužvart (1992)	strong	Permian age; reframed
Storegga / Doggerland	Weninger et al. (2008)	indirect	Time lag $\approx 7,600$ yr

Tabelle 20 (continued)

Evidence Chain	Source	Support	Limitation
Prehistoric RSL / Scandia	Geersen et al. (2024)	strong	Long-term RSL
Viséan protolith Doberlug	Daber (1959); Paech (1989)	strong	Protolith age; refines mechanism
Saale-Unstrut primary Sudete driver	this work, geometric audit	strong	Awaits geophysical confirmation (T1, T6)
Danubius southern anchor (new v6)	this work, K4/G8	strong	Single-point c calibration; test with T10
G7 biaxial extrusion (new v6)	this work, geometric analysis	moderate- strong	$d_{\perp} = 5.2$ km; T9 confirmable

Part IV

The Saale-Unstrut Fragment Impact Hypothesis: Crustal Stress Fields, Biaxial Extrusion, Herzberg Seismic Event, and Revised Plausibility Assessment

34. Introduction to the Impact Hypothesis (Part IV)

Parts I–III established the cartometric, statistical, and geophysical foundations. Part IV develops the Saale-Unstrut Fragment Impact Hypothesis quantitatively and addresses: (i) the revised Sudete rotation mechanics under the corrected pivot; (ii) the biaxial G7 extrusion mechanism and its geometric derivation; (iii) the Herzberg 2024 earthquake correlation; and (iv) the updated plausibility assessment incorporating v6 improvements.

35. Pre-Displacement Geometry and Geology of the Crustal Gap Zone

35.1 Reconstructed Pre-Displacement Positions

The affine transformation implies an ENE displacement of $\overline{\Delta\lambda} = 93.1$ km: $\Delta\lambda_{\text{shift}} = 93.1/(111.3 \times \cos(51.7^\circ)) \approx 1.343^\circ$.

Tabelle 21: Reconstructed pre-displacement positions of the Elster Cluster.

Ptolemaic name	Current identification	Current coords	Pre-shift coords
Budorigum	Doberlug-Kirchhain	13.556°E / 51.619°N	$\approx 12.213^\circ\text{E}$ / 51.619°N
Limis Lucus	Baruth/Mark	13.499°E / 51.993°N	$\approx 12.156^\circ\text{E}$ / 51.993°N
Lugidunum	Falkenberg/Elster	13.271°E / 51.607°N	$\approx 11.928^\circ\text{E}$ / 51.607°N
Stragona	Herzberg/Elster	13.232°E / 51.682°N	$\approx 11.889^\circ\text{E}$ / 51.682°N

The four pre-shift positions cluster in the Saale-Elbe confluence region at approximately the eastern boundary of the Saale-Unstrut outer deformation ring.

35.2 Geology of the Crustal Gap Zone

The mechanically decisive property of the Harz–Elbe–Elster transect is the presence of Zechstein evaporites functioning as a regional décollement across the ≈ 70 km zone between 11.8–12.8°E — a well-documented feature of the Northeast German Basin (Scheck-Wenderoth et al., 2008).

36. Impact Mechanics: Shock Pressure and Transmission

For a stony impactor ($\rho_i = 3,000 \text{ kg m}^{-3}$, $L \approx 2.5 \text{ km}$, $v_i = 20 \text{ km s}^{-1}$):

$$P_0 = \frac{1}{2} \rho_i c_t v_i = 162 \text{ GPa} \quad (25)$$

$$E_k = \frac{1}{2} m_i v_i^2 \approx 4.9 \times 10^{21} \text{ J} \quad (26)$$

Pressure at the Thüringer Wald spine (80–100 km): 4–7 MPa — at the upper limit of fault-reactivation and consistent with rim-deformation interpretation.

37. G7 Biaxial Lateral Extrusion: Geometric Derivation

37.1 Observed Displacement Azimuth

Under $c = 15.2 \text{ km/}^\circ$:

$$\Delta E = +93.9 \text{ km}, \quad \Delta N = +70.6 \text{ km} \quad (27)$$

$$\theta_{G7} = \arctan\left(\frac{93.9}{70.6}\right) = \mathbf{53.0^\circ} \text{ (NNE)} \quad (28)$$

$$|\Delta_{G7}| = \sqrt{93.9^2 + 70.6^2} = \mathbf{117.5 \text{ km}} \quad (29)$$

37.2 Expected Biaxial Extrusion Azimuth

SU–CK axis (Geiseltal $\rightarrow$ Tábör) azimuth:

$$\theta_{\text{Achse}} = \arctan\left(\frac{208.4}{212.6}\right) + 90^\circ = 44.4^\circ + 90^\circ = \mathbf{134.4^\circ} \text{ (SSE)} \quad (30)$$

Lateral extrusion perpendicular to compression axis:

$$\theta_{\text{Extrusion}} = 134.4^\circ - 90^\circ = \boxed{44.4^\circ \text{ (NNE)}} \quad (31)$$

$$\Delta\theta = \theta_{G7} - \theta_{\text{Extrusion}} = 53.0^\circ - 44.4^\circ = \mathbf{8.6^\circ} \quad (32)$$

Geometric match: G7 biaxial extrusion

The observed G7 displacement azimuth (53°) deviates only 8.6° from the theoretically expected biaxial extrusion perpendicular (44.4°) — well within the combined geometric model uncertainty of $\pm 10\text{--}15^\circ$. The 8.6° eastward bias is explained by SU down-range coupling adding a small ENE component to the lateral extrusion.

37.3 G7 Pre-Deformation Position on the Biaxial Axis

$$\lambda_{\text{pre,G7}} = 14.467 - \frac{93.9}{70.0} = 13.126^\circ \text{E} \quad (33)$$

$$\phi_{\text{pre,G7}} = 51.133 - \frac{70.6}{111.3} = 50.499^\circ\text{N} \quad (34)$$

Perpendicular distance from the SU–CK axis to the G7 pre-deformation position:

$$d_{\perp} = 98.0 \times 0.714 + (-92.5) \times 0.700 = 69.97 - 64.75 = \boxed{+5.2 \text{ km NE}} \quad (35)$$

G7 essentially on the biaxial axis

G7's pre-deformation position lies only 5.2 km from the SU–CK compression axis — essentially *on the axis*. A body on the axis experiences *maximum* lateral extrusion force. This geometric arrangement is non-coincidental and provides strong support for the biaxial extrusion interpretation.

37.4 SU vs. CK Contribution to G7 Extrusion

Distance from G7-predisplacement to Geiseltal: 134.7 km; to Tábör: 163.1 km. Inverse-distance weighting: SU $\approx$ 55%, CK $\approx$ 45%. This partition is consistent with the trigger-budget apportionment of §12.

38. The CDF: Multi-Fragment Activation

Direct isotropic shock at the CDF ($r \approx 280$ km): $P \approx 0.21$ MPa — below reactivation threshold. Multi-fragment + Africa-impactor framework is required (§12). GISP2 records four discrete chondritic particle horizons in 533–540 AD (Abbott et al., 2014), providing cosmochemical confirmation.

39. The Bramsche–Český Kráter Biaxial Stress Field

The structural corridor (Bramsche $\rightarrow$ Geiseltal $\rightarrow$ Tábör, azimuth $\approx 120^\circ$, total 530 km) pre-loads the crust to within 5 MPa of Coulomb failure:

$$|\tau|_{\text{crit}} = c_0 + \mu_s \sigma'_n = 2 + 0.6 \times 5 = 5 \text{ MPa} \quad (36)$$

This pre-loading makes the Saale-Unstrut impact the most parsimonious trigger within the corridor.

40. The Elbe Lineament as Primary Transmission Channel

The Elbe Lineament (≈ 500 km, NW–SE, $\approx 310^\circ/130^\circ$) intersects the impact shock field at $r \approx 85$ – 90 km (pressure: 3.5–7 MPa). The NW–SE orientation is geometrically perpendicular to the ENE block displacement — mechanically optimal for dextral transpressive rupture in a Riedel shear geometry. Pre-existing dextral kinematics from Late Cretaceous inversion tectonics (Scheck-Wenderoth et al., 2008) dramatically reduce the required trigger energy.

41. Crustal Translation Kinematics: The –93 km Block Displacement (v6 formulation)

The v6 translation-glide formulation preserves the energy coherence. Translation work along the Zechstein décollement ($\mu \approx 0.1$, $V \approx 2.8 \times 10^4 \text{ km}^3$, $\Delta x = 93 \text{ km}$):

$$W_{\text{translation}} \approx 0.1 \times 6.7 \times 10^{16} \times 9.81 \times 93 \times 10^3 \approx 6 \times 10^{21} \text{ J} \quad (37)$$

This is of the same order as $E_k \approx 4.9 \times 10^{21} \text{ J}$ of the Saale-Unstrut impact, achievable when two co-temporal impacts and the CDF pulse are summed. The translation-glide kinematics is *energetically achievable* where the rigid-rotation formulation of v4 was not.

42. The Český Kráter at Tábor: Structure and Alpine-Carpathian Geodynamics

Structural parameters of the Tábor / Bohemian Massif impact hypothesis, the Alpine-Carpathian bow-shock morphology, and the Bavarian Dark Earth hydrodynamic mechanisms are as described in v5 (§34 of v5). The younger age interpretation (≈ 525 –531 AD) is retained; the conventional $\approx 2 \text{ Ga}$ Rajlich age is attributed to inheritance of pre-existing zircon ages.

43. The Herzberg Earthquake of 18 October 2024

Tabelle 22: Instrumental parameters of the 18 October 2024 Herzberg earthquake.

Parameter	Value	Source
Date / UTC	18 Oct 2024, 10:50:52	BGR, USGS
Magnitude	M_L 3.1 (BGR)	Instrumental
Hypocentre depth	$\approx 21 \text{ km}$ ($\pm 5 \text{ km}$)	Uni Jena
Epicentre area	Herzberg (Elster) – Doberlug-Kirchhain	BGR
Prior seismicity	None in BGR catalogue	BGR
Historical analogue	Herzberg 1483, intensity IV	City chronicle

The 21 km hypocentre depth rules out anthropogenic causes. The absence of aftershocks is consistent with a complete stress-drop event on a small, isolated residual fault patch in the down-range overthrust zone. The predicted ellipse focus F_2 of the compressed Vistula meander ($\approx 13.519^\circ \text{E}$ / 51.783°N) lies $\approx 16.9 \text{ km}$ from the BGR epicentre centroid — within the combined uncertainty envelope. The interval 1483 $\rightarrow$ 2024 (541 yr) is consistent with a residual tectonic scar accumulating stress through Africa-Europe convergence.

44. Historical and Mythological Corroboration

Four GISP2 chondritic particle horizons (533–540 AD), Byzantine court chronicles, Edessa flood reports, settlement hiatus over the impact centre, and the simultaneous collapse of the Thuringian Kingdom all converge on a catastrophic central European event in 525–540 AD. Michael the Great's reports of dark flood waters and surface-exposed animal bones are consistent with the ED-E model and the Geiseltal Eocene fossil excavation mechanism respectively.

45. Integrated Plausibility Assessment (v6)

The v5 score (105/140, $\approx 75\%$) is updated in v6 by adding new dimensions for the Danubius anchor, bias calibration, G7 biaxial extrusion, and pivot clarification.

Tabelle 23: Composite plausibility scores (v6). Net gain from new sub-aspects; v5 score 105/140 $\rightarrow$ v6 upgraded.

Dimension	Sub-aspect	Score	Key factor
Geometric coherence	Oblique impact axis	4/5	angular scatter $\approx 18^\circ$
	Bramsche–SU–CK		
	SU outer rim =	4.5/5	geometrically clean fit
	Oberhof–Ilmenau		
	Pre-shift cluster at outer ring boundary	4/5	quantitatively verified
	Elbe-Elster as down-range lobe	4/5	resolves SU vs. rim tension
	G7 on SU–CK axis ($d_\perp = 5.2$ km) [NEW v6]	4.5/5	non-coincidental; maximises extrusion force
Impact physics	Direct shock at Elbe Lineament	3/5	lower threshold
	Fault-guided transmission	4/5	Elbe Lineament waveguide
	CDF activation by single SU	1/5	insufficient; multi-fragment req.
	Multi-fragment scenario (GISP2)	3.5/5	supported
	Biaxial Bramsche–CK pre-loading	4/5	well-supported
	SU = primary Sudete driver	4.5/5	50–60 km rim displacement

Tabelle 23 (continued)

Dimension	Sub-aspect	Score	Key factor
	G7 biaxial extrusion ($\Delta\theta = 8.6^\circ$) [NEW v6]	4.5/5	azimuth match within uncertainty
Geological evidence	Zechstein décollement	4/5	independently established
	Doberlug Viséan + SU overprint	4/5	geologically defensible
	Elbe Lineament dextral kinematics	4/5	Late Cretaceous precedent
	Multi-layer factor 2.4 kinematics	4/5	hard to explain otherwise
Český Kráter model	Ring fracture to Saxon-Lusatian domain	4/5	
	Tábor younger age	2.5/5	no independent dating
	Alpine-Carpathian bow-shock	3/5	FE-modelling needed
Historical record	GISP2 chondritic horizons	5/5	direct confirmation
	Settlement hiatus over impact centre	4/5	well-documented
	Fall of Thuringian Kingdom	3.5/5	spatial coincidence
	Michael the Great: dark flood waters	3.5/5	consistent
	Michael the Great: bones/skeletons	3/5	speculative
Herzberg 2024	$F_2 \leftrightarrow$ epicentre, 16.9 km	3.5/5	within uncertainty
	Hypocentre 21 km depth	4/5	non-anthropogenic
	541-yr recurrence	3/5	single interval
Kinematic taxonomy (v5)	Elster T-G (Senftenberg backstop)	4.5/5	geometrically consistent
	Sudete rigid rotation $+35^\circ$	4.5/5	2% distance preservation
	Trigger budget self-consistency	3.5/5	multi-trigger superposition
	Main-valley buckling	3/5	suggestive; FE needed
v6 additions	Danubius K4 bias calibration	4.5/5	G6 $r_{\text{corr}} = 12.0$ km; internally consistent

[NEW]

Tabelle 23 (continued)

Dimension	Sub-aspect	Score	Key factor
Falsifiability	SSE component (–16.1 km, $p = 0.035$)	3.5/5	marginal; sens. to c
	Pivot clarification (G5 ≠ pivot)	4/5	structurally consistent; T9 testable
	Anduaetium / Bamberg hypothesis	2.5/5	large uncertainty ±100 km; T10
	T1 shock-quartz drill programme	5/5	definitive
	T2 Bouguer anomaly ring survey	4/5	executable
	T6–T8 (v5) + T9–T11 (v6)	4/5	specific predictions
Cumulative score (v6)		115/155	≈74 % : modest improvement; new sub-aspects balanced by honest uncertainty on Anduaetium

46. Overall Conclusions and Outlook

This Version 6 Geodynamic Reinterpretation Model extends the coherent, falsifiable framework of v5 with three principal structural improvements and several supporting refinements:

1. **Cartometric foundation (unchanged):** $\overline{\Delta\lambda} = -93.1$ km ($t = -13.7$, $p < 0.001$, $df = 3$).
2. **Southern Danubius anchor (new v6):** G8 promoted to K4; latitude bias $c = 15.2$ km/ $^\circ$; G6 bias-corrected $r_{\text{corr}} = 12.0$ km (near-perfect rotation confirmation).
3. **Pivot clarification (new v6):** G5 is the Ptolemaic NW endpoint of Sudete Mons, not the rotation pivot. The geometric pivot at **Waltershausen** ($10^\circ 33'E$ / $50^\circ 53'N$) is near the block's longitudinal centre.
4. **G7 biaxial lateral extrusion (new v6):** Pre-deformation G7 essentially on SU–CK compression axis ($d_\perp = 5.2$ km); observed azimuth 53° , expected 44° ; discrepancy 8.6° within uncertainty. E-component = décollement-coupled (identical to Elster Cluster); N-component = free lateral extrusion. More parsimonious than v5 backstop-collision model.
5. **SSE component of Elster translation (new v6):** -16.1 km S ($p \approx 0.035$); Elster azimuth $\approx 100^\circ$; CDF NNW extrusion filtered by Zechstein décollement geometry.
6. **NW-flank dual alignment (new v6):** G5 at outer SU ring margin (106 km from Stolberg) and in biaxial corridor (azimuth $\approx 140^\circ$ from Bramsche).
7. **Anduaetium/Bamberg hypothesis (new v6):** Tentative second Danubius anchor, uncertainty $\pm \approx 100$ km; geodynamically displaced by Český Kráter; testable.
8. **Kinematic taxonomy (from v5, confirmed v6), multi-layer kinematics, Saale-Unstrut ($\sim 55\%$ Sudete rotation), three-vector model, trigger budget, Main-valley buckling, anthracite reframing, Event-Dark-Earth:** all unchanged and confirmed.
9. **Integrated assessment:** Cumulative plausibility $\approx 74\%$ (115/155), reflecting a model that is internally consistent, multiply constrained, and falsifiable.

Priority Falsification Tests**T1 (decisive, retained):**

Core drilling <10 km from the postulated Saale-Unstrut impact centre (Schnellroda–Geiseltal–West). SHRIMP/Raman analysis for shocked quartz PDFs and suevite-facies breccia. Predicted: > 0.5 GPa shock signature.

T2 (rapid, retained):

High-resolution Bouguer gravimetric survey (1:50,000 scale, 50 km radius). Predicted: circular negative anomaly of –20 to –40 mGal.

T3 (seismological, retained):

8–10 permanent broadband stations in 20 km radius around ellipse focus F_2 (Nexdorf–Herzberg area). Predicted: residual micro-seismicity at 15–25 km depth.

T4 (sedimentological, retained):

Targeted micromorphological, geochemical (PAH, Cl/Br, iridium, Ni), and palynological re-analysis of Dark Earth profiles against ED-E predictions P1–P6.

T5 (geochronological, retained):

Independent OSL/SHRIMP dating of Český Kráter breccia matrix to test the younger-age interpretation.

T6 (décollement verification, from v5):

Reflection-seismic profiling across the Halle-Bitterfeld zone to image the Zechstein décollement. Expected: E-component displacement horizon postdating Tertiary cover.

T7 (from v5): Main-valley sediments + Doberlug:

(a) High-resolution sediment cores at the Spessart (Maindreieck) inflection for stratigraphic discontinuity at 6th-century horizon. (b) Deep cores at Doberlug for Viséan palynomorphs with shallow overprint signatures.

T8 (Africa-impactor search, from v5):

Cosmochemical analysis of Southern African continental shelf sediment cores for mid-1st-millennium AD iridium anomaly or shocked-quartz horizon.

T9 (new v6): Waltershausen hinge via palaeostress indicators.

Micromorphological palaeostress investigation (slickensides, stylolites, fault-plane solutions, AMS fabric) in the **Waltershausen–Eisenach–Gotha corridor** ($\approx 10.3\text{--}10.8^\circ\text{E} / 50.8\text{--}51.0^\circ\text{N}$), targeting the inferred rotation hinge of the Sudete-Mons block. Expected: (a) The hinge zone at Waltershausen shows dominantly

plane-strain indicators and relatively low deviatoric stress intensity, consistent with a mechanically fixed pivot; (b) the NW terminus area (G5, Neukirchen–Eisenach sector, ≈ 86 km west of hinge) shows high-deviatoric dextral shear fabric with NNW transport direction, reflecting the ≈ 52 km northward sweep; (c) the SE terminus area (G6, Lobenstein sector, ≈ 90 km east of hinge) shows sinistral shear and SSE transport indicators, reflecting the ≈ 54 km southward sweep. Principal compressive stress near the hinge should be oriented $\approx 115^\circ$ – 130° , consistent with the biaxial Bramsche–SU corridor axis.

T10 (new v6): Bamberg / Anduaetium as second Danubius anchor.

The tentative identification of Anduaetium ($\lambda_P = 40^\circ 30'$, $\phi_P = 47^\circ 40'$) with the Bamberg / Regnitz–Main confluence area ($\approx 10.89^\circ\text{E}$ / 49.89°N) constitutes a testable secondary southern anchor for the bias-gradient calibration. Note that Würzburg, situated within the geodynamically compressed Maindreieck zone, is **explicitly excluded** as a calibration reference due to the Main-valley kink-fold deformation documented in §13; Bamberg lies west of this deformation zone and is therefore preferable. Test: (a) Targeted archaeological investigation of the Bamberg / Regnitz area for Roman-period or Migration-period settlement layers consistent with an Anduaetium identification. (b) Cartometric: if Anduaetium's pre-deformation position was indeed near Bamberg, the observed ≈ 72 km residual (bias-corrected, eastward) should correspond to a verifiable eastward displacement of the Main corridor in this sector, providing an independent test of both the bias gradient $c = 15.2 \text{ km}/^\circ_P$ and the Český Kráter deformation field.

T11 (new v6): Paleoclimatological stability of the Taunus.

Pollen-based paleotemperature reconstruction at the Taunus (G8 / K4) and the Geiseltal (SU centre) for the 5th–6th-century window. Under the adopted scenario ($c = 15.2$, $T_{G8} = 0$), the Taunus was geologically stable; no anomalous paleotemperature differential between Taunus and Geiseltal is expected beyond that produced by regional climate gradient. If a large (≥ 50 km equivalent) northward drift of the Taunus had occurred, a measurable latitudinal temperature anomaly would be expected in the contemporaneous pollen record. Confirmation of Taunus stability supports $c \approx 15.2$; discovery of anomalous cooling at the Taunus would support lower c values with tectonic Taunus northward motion.

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A. Appendix: Complete Coordinate Gazetteer

A.1 Anchor Points, Settlements, Rivers, and Mountains (v6: K4 added; G5/G7 kinematic class updated)

Version 6 updates to gazetteer

K4 (= G8 / Abnoba Mons W) added as southern anchor. G5 kinematic class: R (NW mobile terminus; Waltershausen central-block pivot at 10°33'E / 50°53'N, ≈86 km to the east, on southern SU outer rim). G7 kinematic class: T-G + biaxial NE extrusion. Anduaetium tentative identification added as App. A.2.

Tabelle 24: Full gazetteer (v6). K4 = Danubius southern anchor. Kinematic classes updated per §7. T-G = translation-glide; R = rigid-rotation; T-G+r = predominantly translation; BE = biaxial extrusion.

#	Ptolemaic name	Identification	λ_P (°)	ϕ_P (°)	λ_M (° E)	ϕ_M (° N)	$\Delta\lambda$ (km)	$\Delta\phi$ (km)	r (km)
K1	Rhenus Flu. (central mouth)	Hengelo / Enschede area	27.00	53.17	6.750	52.250	0.0	0.0	0.0
K2	Albis Flu. (mouth)	NW of Bremen	31.00	56.25	8.583	53.183	0.0	0.0	0.0
K3	Vistula Flu. (mouth)	Oderberg (Brandenburg / Oder)	45.00	56.00	14.150	52.867	0.0	0.0	0.0
K4	Abnoba Mons W	Taunus / Großer Feldberg	31.00	49.00	7.867	50.017	+11.2	+91.2	91.9
<i>(= G8, promoted to K4 southern Danubius anchor in v6; $\Delta\phi_{corr} = 0$ after bias; residual $r_{corr} = 11.2$ km)</i>									
F1	Vistula Flu. main source	Königswartha (Spree source)	44.00	52.50	14.367	51.283	-61.5	+52.1	80.5
F2	Vistula Flu. western source	Königsbrück / Pulsnitz	40.17	52.67	13.883	51.267	-133.0	+67.4	149.2

Tabelle 24 (continued)

#	Ptolemaic name	Identification	λ_P	ϕ_P	λ_M	ϕ_M	$\Delta\lambda$	$\Delta\phi$	r
F3	Chalusus Flu. (mouth)	Havelberg (Havel → Elbe)	37.00	56.00	12.067	52.817	−74.5	+21.0	77.4
F4	Suebus Flu. (mouth)	Neuruppin / Fehrbellin	39.50	56.00	12.900	52.817	−63.4	+16.4	65.5
F5	Viadua Flu. (mouth)	Finowfurt / Marienwerder	42.50	56.00	13.633	52.850	−32.3	+7.1	33.1
S1	Agrippinensis*	Cologne (Altstadt)	27.67	51.17	6.958	50.941	−6.9	+73.0	73.3
S2	Aliso*	Haltern am See	28.00	51.50	7.324	51.712	−20.9	−1.8	21.0
S3	Budorigum	Doberlug- Kirchhain	41.00	52.67	13.556	51.619	−87.1	+26.9	91.2
S4	Calisia	Calau (Nie- derlausitz)	43.75	52.83	13.960	51.743	−38.2	+13.7	40.6
S5	Limis Lucus	Baruth / Mark	41.00	53.50	13.499	51.993	−78.2	+9.2	78.7
S6	Lugidunum	Falkenberg / Elster	39.50	52.50	13.269	51.606	−109.5	+24.5	112.2
S7	Stragona	Herzberg / Elster	39.67	52.33	13.200	51.667	−101.0	+11.8	101.7
S8	Treva	Bremen (city centre)	33.00	55.67	8.939	53.036	+26.6	−7.9	27.8
S9	Lirimiris	Bispingen / Soltau area	34.50	55.50	10.010	53.107	−5.9	−24.6	25.3
G1	Asciburgius Mons NW	E. of Magdeburg / W. Fläming	39.00	54.00	12.283	52.167	−46.5	+17.6	49.7
G2	Asciburgius Mons SE	Calauer Schweiz / Senftenberg	44.00	52.50	13.933	51.583	−31.3	+18.7	36.3
G3	Melibocus Mons W	Harz W / Weser-Leine uplands	33.00	52.50	9.433	52.000	−23.3	−7.2	24.4

Tabelle 24 (continued)

#	Ptolemaic name	Identification	λ_P	ϕ_P	λ_M	ϕ_M	$\Delta\lambda$	$\Delta\phi$	r
G4	Melibocus Mons E	Harz E / Eisleben	37.00	52.50	11.283	51.517	−41.2	+39.1	55.2
G5	Sudete Mons W	TW NW boundary / Kassel area	34.00	50.00	9.583	51.233	−19.8	−13.7	23.9
<i>G5 is the Ptolemaic NW terminus of the Sudete Mons block (Thüringer Wald). Pre-deformation position: Neukirchen area ($9^\circ 19' E$ / $50^\circ 53' N$), ≈ 86 km due west of the Waltershausen rotation pivot ($10^\circ 33' E$ / $50^\circ 53' N$) — same latitude, consistent with the E–W pre-rotation block geometry. After 35° dextral rotation about this central block hinge, G5 swept ≈ 52 km northward to its modern cartometric position (Kassel area). Rotation-corrected residual ≈ 11 km (within identification uncertainty). G5 lies on the outer SU deformation ring boundary (≈ 106 km from Stolberg) and within the biaxial Bramsche–Geiseltal stress corridor — the maximally loaded mobile NW flank.</i>									
G6	Sudete Mons E	Thur. Slate Mts. / Lobenstein	40.00	50.00	11.533	50.367	+11.2	+71.6	72.5
<i>G6 is the Ptolemaic SE terminus of the Sudete Mons block (Thüringer Schiefergebirge/Lobenstein area). Pre-deformation position: $\approx 11^\circ 49' E$ / $50^\circ 49' N$, ≈ 90 km nearly due east of the rotation pivot at Waltershausen ($10^\circ 33' E$ / $50^\circ 53' N$). After 35° dextral rotation about this central block hinge, G6 swept ≈ 54 km southward to its modern position, approaching the Danubius Fl. (Main). Rotation-corrected residual ≈ 0.1 km (essentially exact): the rotation model predicts G6's modern position to within cartometric noise. The eastern Sudete Mons thus approached the Danubius reference line from ≈ 110–120 km (pre-rotation) to ≈ 30–40 km (post-rotation).</i>									
G7	Sarmate Mons N	Lusatian Highlands / Zittauer Geb.	43.50	50.50	14.467	51.133	−93.9	−2.2	94.0
<i>T-G + biaxial NE lateral extrusion; pre-deformation position 5.2 km from SU–CK axis; azimuth 53° vs. expected 44.4°; $\Delta N = +70.6$ km bias-corrected.</i>									

* Gallia Belgica (different measurement system); evaluated separately.

Transformation formulae (v6, unchanged from v5): $\hat{\lambda}_{\text{mod}} = -8.114 + 0.3989 \lambda_P + 0.0770 \phi_P$;

$$\hat{\phi}_{\text{mod}} = +35.458 - 0.0167 \lambda_P + 0.3244 \phi_P.$$

Bias correction (new v6): $\Delta\phi_{\text{bias}} = 15.2 \times \max(0, 55^\circ - \phi_P)$ km; $\Delta\phi_{\text{corr}} = \Delta\phi_{\text{obs}} - \Delta\phi_{\text{bias}}$.

Internal validation: Albis Fluvius source within the rotating block. The online Gazetteer (Mildner 2026, www.germania-magna.de) identifies the Albis Fluvius source (Ptolemaic $39^\circ/50^\circ$) with the eastern Thüringer Wald between Ilmenau and Saalfeld, displaced to $\approx 50^\circ 40' \text{N} / 11^\circ 18' \text{E}$. This point lay *within* the rotating block. Under the Waltershausen rotation model, a block-interior point at $\approx 11.0^\circ \text{E} / 50.8^\circ \text{N}$ (lever arm ≈ 47 km from the pivot) predicts a chord displacement of $2 \times 47 \times \sin(17.5^\circ) \approx 28$ km southward, consistent with the observed southward relocation toward the Schwarza/Saale headwater region. This constitutes an additional internal consistency check on the $+35^\circ$ rotation.

A.2 Tentative Anduaetium Identification (NEW in v6)

Tabelle 25: Anduaetium / Bamberg hypothesis: tentative secondary Danubius anchor with large uncertainty. *Hypothetical; not a confirmed identification.*

Ptolemaic name	λ_P	ϕ_P	Notes
Anduaetium /	40°30'	47°40'	Documented in Book II, Ch. 10; in the southern Barbaricum / Danubius zone
<i>Tentative modern identification:</i>			
Bamberg area	10.89°E	49.89°N	Bamberg lies on the Regnitz river, ≈ 3 km upstream of the Regnitz–Main confluence; thus near but not directly on the Main
Model prediction	11.71°E	50.25°N	Affine transformation output
Uncorrected residual	$\approx +59$ km W; +40 km N	$r \approx$ 71 km	Before bias correction
Bias correction	–111.4 km	—	$15.2 \times (55 - 47.67) = 111.4$ km
Corrected $\Delta\phi$	–71.7 km (S)	—	Bias-corrected ϕ -residual: the affine model predicts 71.7 km <i>north</i> of Bamberg (after coastline-shift correction). Combined with the $\Delta\lambda = +59$ km (affine prediction east of Bamberg), the total bias-corrected displacement vector is ≈ 95 km towards NNE — consistent with dual CK-driven eastward and northward forcing in the biaxial stress field. Note: interpretation is highly uncertain given the ± 100 km identification uncertainty.
Position uncertainty	$\pm \approx$ 100 km	—	Due to massive biaxial overprinting in this region

The ≈ 72 km northward discrepancy after bias correction is consistent with a northward displacement of Anduaetium from its original position (south of Bamberg) toward the Český Kráter in the 6th-century deformation episode. This interpretation is tentative and subject to a factor ± 100 km uncertainty. The Bamberg / Regnitz–Main area remains a candidate location for the original settlement, with the Regnitz functioning as a tributary of the Main / ancient Danubius rather than the main river channel itself.

A.3 Saale-Unstrut Crater Geometry (from v5, unchanged)

Tabelle 26: Saale-Unstrut Fragment Impact: geometric parameters (working hypothesis; not confirmed in peer-reviewed literature).

Element	Identification	λ (°E)	ϕ (°N)	d from Stolberg (km)	Notes
Inner crater centre	Schnellroda/ Geiseltal	11.73	51.33	≈ 57	transient cavity
Outer-ring centre	Stolberg	11.00	51.57	0	ring-fit centre
Outer deformation diameter	—	—	—	—	180–200 km
<i>Southern outer rim</i>					
Oberhof	TW high ridge	10.73	50.70	≈ 99	excellent rim fit
Ilmenau	TW NE margin	10.91	50.68	≈ 99	excellent rim fit
Eisenach (TW NW)	—	10.32	50.98	≈ 81	inner edge
<i>Down-range lobe and backstop</i>					
Herzberg/Elster	—	13.23	51.68	≈ 154	down-range overthrust
Senftenberg	Lausitz backstop	13.97	51.54	≈ 208	arrest of Elster glide
<i>Virtual pivot and outer reference</i>					
Waltershausen pivot (v6)	Sudete terminus	10.54	50.88	≈ 83	on southern outer rim — natural rotation hinge of the Thüringer Wald block
Bramsche pluton	passive endpoint	8.00	52.42	≈ 227	NNW structural limit

A.4 CDF and Elbe-Lineament Reference Points

Tabelle 27: Reference nodes of the CDF/TTZ and Elbe Lineament.

Node / Segment	λ (°E)	ϕ (°N)	Notes
<i>CDF / Trans-European Suture Zone</i>			
CDF-W (central North Sea)	4.5	54.5	MONA LISA 3
CDF-Mecklenburg-Vorpommern	11.0	54.2	NE-Germany main trace
CDF-Rügen-West (Wiek Fault)	13.3	54.5	
TTZ-transition (Pomerania)	16.5	54.0	link to Polish Tornquist
<i>Elbe Lineament</i>			
SW endpoint (Dresden-Meißen)	13.4	51.1	Saxothuringian / N German Basin boundary
Central node (Halle-Magdeburg)	12.0	51.9	intersection with Asciburgius hinge
NW endpoint (Bremerhaven)	8.5	53.5	North Sea continuation

A.5 Mineral Deposit Coordinates

Tabelle 28: Coordinates of mineral deposits. d_{CK} = distance to Český Kráter centre; d_{SU} = distance to Saale-Unstrut inner crater. All WGS84. (Unchanged from v5.)

Deposit / Site	λ (°E)	ϕ (°N)	d_{CK} (km)	d_{SU} (km)	Type
<i>Hard coal and anthracite</i>					
Lugau-Oelsnitz	12.729	50.725	212	100	Inter-impact corridor
Freital / Döhlen Basin	13.657	50.989	240	155	Hard coal
Doberlug-Kirchhain	13.554	51.616	282	130	Viséan anthracite ; SU down-range overprint (v5/v6)
Barsinghausen	9.470	52.299	490	88	Hard coal
Ibbenbüren	7.740	52.286	585	126	Hard coal
<i>Kaolin</i>					
Caminau (Upper Lusatia)	14.343	51.337	265	169	Zone B
Kemmlitz	12.993	51.227	271	101	Zone C (marginal)
Meissen-N (Ockrilla)	13.501	51.211	240	137	Zone B
Karlovy Vary	12.879	50.230	184	86	Zone B
Hirschau / Schnaittenbach	11.961	49.543	218	186	Zone B
<i>Kupferschiefer</i>					

Tabelle 28 (continued)

Deposit / Site	λ (°E)	ϕ (°N)	d_{CK} (km)	d_{SU} (km)	Type
Mansfeld / Eisleben	11.589	51.602	323	36	Zechstein Cu-Ag
Sangerhausen	11.292	51.483	320	44	Zechstein Permian